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An Illustrated Weekly Journal

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EASY MONEY

It is a popular myth that all the best engineers hail from Glasgow. Yet in that stolid stone city, post-war conditions are producing an increasing number of unskilled manual workers. A recently published study by two authorities at Glasgow University shows that young men who have been trained for skilled or semi-skilled work are leaving to become unskilled manual workers—apparently because they can earn as much or more in that way. The deterioration is most marked in the group which has completed National Service. There is no reason to suppose that Glasgow is unique in this respect. It is worth looking at the reasons, and asking why a nation which has a great tradition of universal education cannot get better value in terms of more skilled technicians and craftsmen.

The study was concerned primarily with the performance of a group of 568 men between the ages of 20 and 22. A considerable amount of information concerning their personal history had been gathered previously. It was found convenient to divide the survey into two groups: one consisting of 346 men who had done their National Service and returned to civil life by the time they were 20 years of age, the other consisting of 222 of the same age who, having been rejected on medical grounds as unfit for service, had remained in civil life in Glasgow since they had left school. Common to both groups was the fact that every member had left school at the age of 14 on January 26, 1947. The report does not give details of the progress of all the younger generation of Glasgow, but it does give a picture of a large and important part of it—70·5 per cent. of the total number who left school at the age of 14 on the day selected were included in the survey.

The figures show that of those who had been serving apprenticeships at the age of 17, only 64 per cent. of those who had not been called up were in skilled work at the age of 22, while only 59 per cent. of those who were called up were in skilled work at the same age. Much better results might have been expected of the latter group since it contained a higher proportion of youths with good scholastic ability, and their physical fitness was superior. National Service was found to have had an unsettling influence, but the report shows the effect of service to be much less marked than the influence of bad social and environmental conditions. These conditions probably have some bearing on the drift away from skilled work.

Many boys have to leave school at the earliest opportunity because of circumstances over which they have no control. It is not possible to dismiss the serious drift from skilled trades as ascribable to incorrigeable malcontents—the proportion involved in the movement is too high. Clearly, unskilled jobs are offering greater opportunities to earn high wages. This is one of the unwelcome by-products of full employment. It would seem that although a man may be told that a skilled job offers good prospects, the promise alone carries little weight. Either security of employment has no special significance to Glasgow youth in the 1950's, or the past behaviour of the employer has not encouraged confidence in his perspicacity or his credibility.

If we as a nation want the standard of living appropriate to an advanced industrial society then we must be just that. We cannot rely on a small group of professional and skilled men leading a vast mass of unskilled labour. Such a policy can be left to other nations which have not got the same tradition of universal education. At a recent meeting of the Institution of Engineers and Shipbuilders in Scotland, two papers were presented on the subject of education and training. Dr. W. S. Cormack stated in his paper on the education and training of technicians and craftsmen that there is no simple answer to this problem of shortage of technologists, technicians and craftsmen. "All who are in earnest about solving it should welcome any number of partial solutions which might together add up to something approaching completeness and be willing to put them to the pragmatic test. More is needed than advice and encouragement to students to attend courses under the present evening or day-release systems. New schemes offering facilities hitherto not available will have to be devised by educationalists and professional bodies and in this connection it is to be hoped that customs and practices dating back a generation or more will not be used as an excuse for rejecting novel proposals. If regulations, whether they be those of Government departments, local authorities, employers' associations, professional bodies, or trade unions, are to be cited as reasons for not even trying out new schemes, the shortage of craftsmen may well become chronic and emergency give way to crisis."

If a serious attempt is made to solve this aspect of the problem the other aspect will perhaps be automatically solved. When the value of skilled labour is recognised by solid acts instead of lip service, then technicians and craftsmen can plan for the future, knowing their skill will be valued. As long as there exists widespread indifference to skill there is nothing to encourage its cultivation. The authors of this revealing survey have exposed this unhappy situation; is there anyone who can explain why, in Glasgow

and perhaps elsewhere, there is such a demand for unskilled workers. What economic or commercial factors have produced this degradation?

In Their Early Twenties, by T. Ferguson and J. Cunnison. (Nuffield Founda ion). Oxford University Press. (12*s.* 6*d.*)

* * *

Plain Words

A recent report published by the Institution of Electrical Engineers goes into considerable detail as to how graduates may be trained in the quickest, most efficient way. The proposals are the result of the co-operation of all branches of electrical engineering on a representative committee; the result of interviews with graduates by experienced engineers; the result of a detailed study of the needs of both suppliers and consumers. But the proposals are not likely to be adopted by everyone.

Although many graduates will be able to follow the two-year course of practical training recommended, many will not. The most powerful deterrent that prevents a young man from embarking on a graduate apprenticeship is National Service. Any graduate with a reasonable degree can go straight into a deferred occupation and avoid all the discomforts of military service; but such occupations do not include the period of practical training recommended by the Institution of Electrical Engineers. Is it surprising that last year about 40 per cent. of the graduates in electrical engineering did not enter an apprenticeship scheme?

It is generally accepted that the output of graduates must be doubled if our industrial expansion is to continue. Yet this increase alone is of little value if the graduates do not receive a comprehensive practical training. The stranglehold that National Service has on the supply of graduate apprentices must be removed if an adequate number of chartered electrical engineers are to be available.

There is a second obstacle to the training of graduates that is of considerable concern to the joint committee on practical training in the electrical engineering industry. Most of the burden of providing the training facilities has fallen on the industrial giants. The increasing number of graduates makes it imperative that the load be distributed over a larger number of firms. Too many specialist firms have been content to pirate trained men from large firms. The committee make it clear that they recognise the difficulty that such firms acting individually would have in providing training, but offer as a solution the suggestion that they should co-operate. Each firm in a group would provide a particular part of the practical training programme and none would have to provide a complete course. Such a system has certain administrative problems. However, a member of the Institution put the situation clearly—"The demand for graduates is so great that if small firms do not co-operate they won't get any."

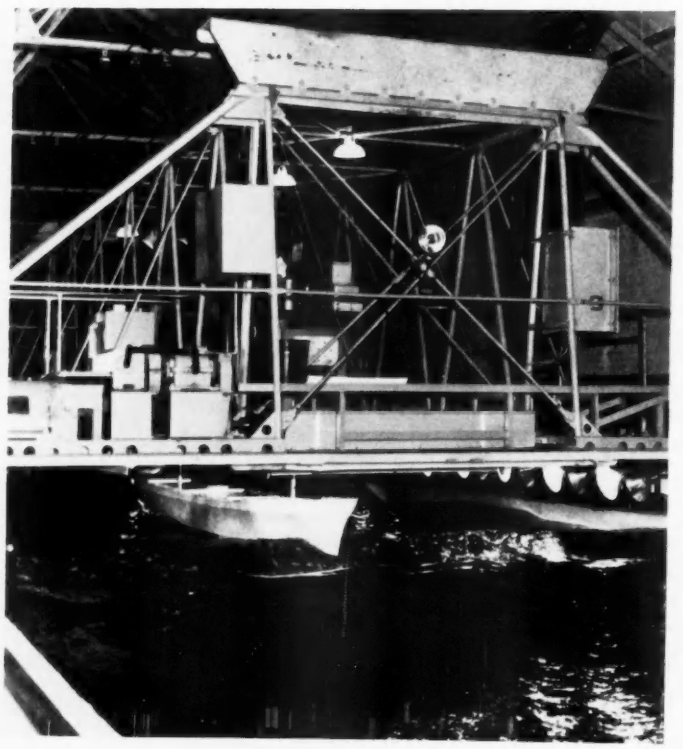
The Training of Graduates, I.E.E., Savoy Place, London, W.C.2. (2*s.*)

MAKING 2 FT. WAVES FOR 20 FT. SHIP MODELS

William Froude, the pioneer of scientific ship-model testing, constructed the first experimental tank for that purpose at Chelston Cross, near Torquay, in 1870. He had already developed basically his theory for the prediction of the performance of ships and it was to establish this theory that he persuaded the Admiralty to sanction the construction of the tank. Froude himself was responsible for its design and for the design of the towing and recording apparatus.

The Torquay tank was dismantled in 1886, but it had early proved the value of ship-model experiments and had convinced William Denny, of Dumbarton, that similar research would be of advantage in the design of merchant ships, particularly the type of fast channel steamer in which the Denny firm specialised; Froude's work, of course, had been directed primarily towards the design of warships. Denny therefore built a tank in his shipyard in Dumbarton, where it is still in use—the first to be constructed for a private shipyard, and probably now the oldest in the world.

The work of warship model-testing was transferred to Haslar when the Torquay tank was discontinued, and much of Froude's apparatus was re-erected there. More and more it became evident that continued improvement in the propulsion of ships depended upon the use of ship-model research and experiment, and, while the establishment in 1908, through the munificence of Sir Alfred Yarrow, of the Froude Tank at the National Physical Laboratory, eventually made such facilities available to firms who could not afford to create similar departments, some of the larger firms had realised already that it would be to their advantage to conduct such researches on their own premises.



The model towing carriage travels at speeds of up to 20 ft. per second.

The first to do so were John Brown and Company, at Clydebank, whose tank was completed about 53 years ago. It was fully described and illustrated in our issue of April 27, 1906 (vol. 81, page 541) and was the first in this country to have an electrically-propelled carriage. The architect was J. M. Crawford, of Glasgow, who subsequently approached Vickers, Sons and Maxim, Limited, with a proposal for a similar tank at their Barrow shipyard. This scheme did not materialise, but in 1911 the then chief naval architect of Vickers Limited, Mr. T. G. Owens (who later took the name of Thurston and is best remembered as Sir George Owens Thurston) revived the scheme, which quickly came to fruition under his energetic direction. Plans were prepared by the Erith office of Vickers Limited for a tank of generally similar size as that in the earlier proposal, but with more extensive workshop and office facilities; this was erected at St. Albans in 1911-12. In charge of the new tank from its inception was Mr. Benjamin Pryor, M.I.N.A., who had worked with Froude at Torquay and had been assistant naval architect in the Armstrong shipyard at Elswick. The first model experiments were run at St. Albans in February, 1913.

As at present equipped, the St. Albans tank is capable of undertaking practically any hydrodynamic investigation that may be required in connection with ships. As is customary, the scale models are made of paraffin wax and are from 10 to 20 ft. in length and may weigh as much as a ton. They may be either towed or self-propelled, in calm water or in waves: a new wave-making apparatus is the latest addition to the equipment. As the tank went into service shortly before the outbreak of the 1914-18 war, initially it was used almost wholly for warship work. Between the wars, in spite of the catastrophic slump in the shipbuilding industry, the staff at St. Albans continued to be fully employed, on flying boats and seaplanes. This work had been started in 1914, and eventually included numerous contracts for the Air Ministry and for other firms; but most of it was transferred to the Royal Aircraft Establishment at Farnborough on the completion there of an experiment tank—which, incidentally, was also built by Vickers-Armstrongs Limited.

When warship building languished, the firm began to concentrate on the construction of large passenger liners and tankers. Unusually extensive programmes of research work were undertaken at St. Albans, resulting in the accumulation of an exceptionally wide range of original and valuable data on these specialised types of vessel.

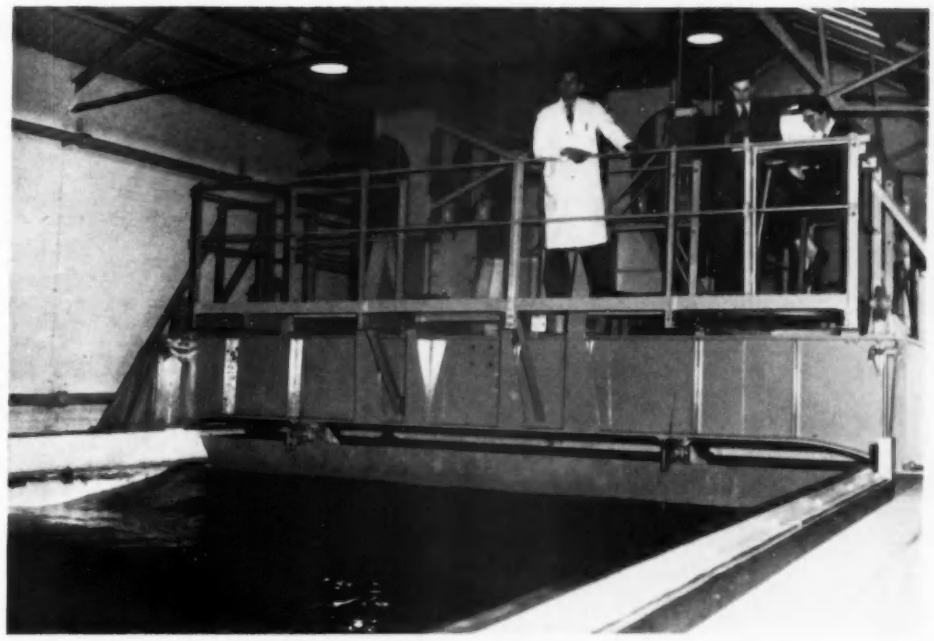
Early in the second World War, the tank was seriously damaged in an air raid, but was speedily repaired and thereafter, by arrangement with the Admiralty, was operated as an associated establishment of the Admiralty Experiment Works at Haslar, being engaged almost entirely on war work; not only warship design, but extending also to special equipment for river and coastal warfare. After the war, there was an enormous increase in the demand for tank-testing facilities by the shipbuilding industry. To meet it, the firm decided to expand the tank's activities to the fullest possible extent and undertook a programme

of re-equipment which began ten years ago with the provision of a new carriage of welded tubular steel and has recently culminated, as mentioned above, in the installation of a new wavemaker.

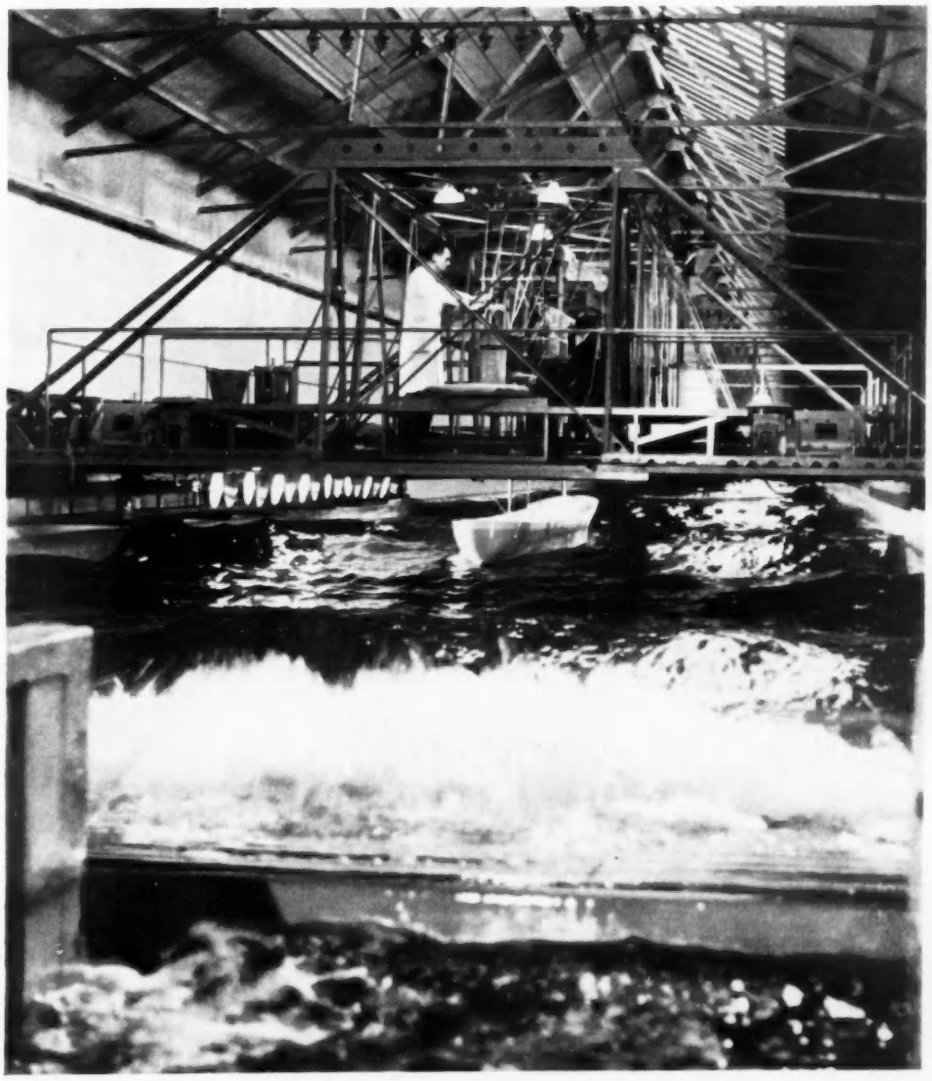
The tank itself is of concrete, 447 ft. 6 in. in length overall, 20 ft. 10 in. wide and 11 ft. 3 in. deep. The length over which model experiments are conducted is 376 ft. 6 in. At one end are docks for storing models, and for ballasting and otherwise preparing them for running. At the other end is the wavemaker. At both ends there are shelving steel beaches to break up the waves created either mechanically or by the passage of models.

The carriage was designed and built at Barrow, and weighs about 9 tons. The electrical installation was designed and made by the Metropolitan-Vickers Electrical Company. There are four 5/20 h.p. driving motors, with Ward-Leonard speed control, giving speeds of up to 20 ft. per second. The wheels on the left-hand side of the carriage (in the direction of running) have two flanges, the left-hand rail being the guide rail; the wheels on the right-hand side have no flanges.

The resistance dynamometer, mounted on the carriage, was designed and built at St. Albans in 1954 and will measure towing forces up to 50 lb. within 0·01 lb. The autographic recording mechanism has been designed for ease of operation and immediate analysis. The motion recorder, which gives a continuous record of the heaving and pitching of the model in waves, is a modified Froude design, constructed at St. Albans last year; and the sinkage recorder, to give a continuous record of the bodily sinkage or rise of the model in still water, was made in the tank workshops in the previous year. The Dekatron counters for recording carriage speed and, in the case of self-propelled models, the propeller revolutions, are designed to give mean readings over any desired time period. There is also an electrically-operated stopwatch for recording carriage speed; this shows the time taken to cover a known distance of travel. The propeller speed control, designed and made jointly by the St. Albans staff and Metropolitan-Vickers Electrical Company, gives electronic control of the output from a metadyne generator. It provides a constant torque at the propeller shaft, simulating the action of a Diesel engine, with correct racing and cut-off when the propeller emerges from a wave. A constant-power control, simulating a turbine drive, is under construction at the present time.



The new wavemaker which has been installed at the Vickers tank.



A shelving "beach" in the foreground breaks up the waves which have traversed the 125 yard length of the ship-model experimental tank.

Alternative sets of self-propulsion gear are available for fitting in the models, namely, a mechanical apparatus of Admiralty design, made by R. W. Munro, Limited, London, N.11, in 1946, and an electrical equipment, designed and made at St. Albans in 1956. The mechanical gear, which was modified in certain respects at St. Albans, measures the propeller thrust and the torque in the shaft by mechanical balancing and records the readings autographically. It is suitable only for use in calm water, but the electrical gear, which measures the thrust and toque by electronically recording the strain on thrust and torque blocks, can be used either in calm water or in waves.

NEW WAVEMAKER

The new wavemaker was designed at St. Albans and made by Vickers-Armstrongs Limited at Elswick between 1953 and 1956. It comprises a plunger of triangular section, built of steel plate and of the full width of the tank, which is moved up and down in the water in simple harmonic motion, the wave height and length being controlled by the amplitude and frequency of the motion, respectively. Waves up to 2 ft. high and 40 ft. long can be created, corresponding to scale to the worst conditions known to exist at sea. The speed control was designed and made by the Metropolitan-Vickers Electrical Company. A flux-resetting transductor and Ward-Leonard gear, with manual or automatic setting, provide either constant speed or a repeatable sequence of varying frequencies, producing trains of regular or irregular waves, respectively. The driving motor is of 25/100 h.p. The machine may be remotely controlled from the carriage if desired. A vertical bulkhead across the tank behind the plunger constrains the waves to travel in one direc-

tion only, and the steel sheet "beach," formed to an exponential curve, at the other end of the tank breaks the waves and prevents reflection. The form of the beach and the section of the plunger were determined by extensive quarter-scale experiments in one of the small docks at the end of the tank.

The wave height recorder, designed and made at St. Albans in 1955, electronically measures the height of the water against a fixed probe and provides an autographic record with automatic continuous calibration.

Fig. 4 Preparing a ship model from paraffin wax.

Other apparatus for the construction of models and for testing them includes a Froude brake, designed and made by R. W. Munro, Limited, in 1914, which was reconstructed with modifications at St. Albans after 40 years' service. It is used to calibrate the mechanical self-propulsion gear, to ascertain the amount of torque lost in the shaft and gearing between the propeller and the point of measurement; in which connection it may be mentioned that the stern tubes and shafts used in the self-propelled models—stainless-steel shafts running in water-lubricated Tufnol bushes carried in brass sterntubes—are also of a special design, developed at St. Albans.

The model cutting machine, designed and built by R. W. Munro, Limited, in 1912 and partly rebuilt at St. Albans in 1953, has two revolving cutters mounted on vertical spindles, cutting the port and starboard sides simultaneously. The model is mounted, keel uppermost, on a table which moves longitudinally beneath a fixed bridge on which the motor-driven cutter heads traverse towards or away from each other at right angles to the table movement. The cutters are raised or lowered in unison by a hand adjustment from one waterline to the next. The traversing movement is controlled through a pantograph mechanism from a pointer with which the operator follows the lines plan of the ship on the machine table, so that a closely-spaced series of accurate waterlines is cut on the rough wax casting. The excess wax between the lines is then removed by hand scraping.

The propeller-milling machine was made at St. Albans in 1956 to a design based on a German original and machines the entire surface of the model propeller from a wooden pattern of about five times the size of the finished model. Compared with the old method of hand finishing, it takes only a quarter of the time and affords much greater accuracy.

For measuring the surface roughness of ships' hulls before running measured-mile trials, the St. Albans workshops have produced roughness gauges to a design developed by the British Shipbuilding Research Association. The motion of a probe, passing over a rough surface, is recorded by a needle scratching on smoked glass. The trace is then magnified optically for analysis.

The St. Albans tank establishment is fully equipped with photographic apparatus for taking both still and cinematograph records and for subsequent developing or other processing. The tank carriage is fitted with floodlights below the platform to illuminate the model.

The work carried out at St. Albans falls into four broad categories, namely, routine commercial testing for ships to be built by Vickers-Armstrongs Limited; similar work for other builders or for shipowners; research work designed to improve hull design and the prediction of propulsive performance on trial and in service; and research work for the British Shipbuilding Research Association. The number of models requiring to be tested for a given ship may vary from two or three for an ordinary single-screw vessel to as many as 15 for high-speed passenger liners such as the new Orient liner Oriana, a model of which was run in the tank on the occasion of our recent visit. Some of the forms for ships to be built by Vickers-Armstrongs Limited are supplied by the shipyard staffs of naval architects, of which department Mr. Austin Kelly, M.B.E., M.I.N.A., is the head, and some by the St. Albans staff, working under the immediate direction of the superintendent of the tank, Mr. David Moor, B.Sc., A.M.I.N.A.

The St. Albans tank is the largest of those privately owned in the United Kingdom, and in size is second only to those of the Admiralty Experiment Works and the National Physical Laboratory. The staff number 37 and include 12 naval architects and draughtsmen and ten technical assistants, tracers and computers; of these, seven have degrees in naval architecture and two in mathematics. The remaining staff comprise a shorthand-typist, five instrument-makers, five joiners, and four clay moulders and labourers. Down to the end of 1956, 716 models had been tested or were in hand, covering practically every type of seagoing vessel as well as flying boats, seaplanes, torpedoes, and three airship models. Of the merchant-ship models, 109 were for passenger vessels (of which 38 models were for Orient liner designs) and, by a coincidence, exactly the same number for ordinary cargo vessels. Tanker models numbered 72. In the warship categories, there were 19 models for battleships, 23 for cruisers, 20 for destroyers, three for aircraft carriers, and (as might be expected in view of the firm's long association with submarine construction) 35 for submarines. Many of these warship classifications would be much larger, of course, were it not that so much of the tank-testing of warship models is done by the Admiralty.

The above total of 716 models, impressive as it is, does not include models, etc., tested during the second World War for the Inter-Services Research Bureau. During the past two years, the average output of models at St. Albans has been 75 per annum; a total which may be expected to increase, now that the re-equipment of the tank is virtually completed.

PISTON RING BEHAVIOUR AND EFFECT ON LUBRICATION

RESEARCH SHOWS BEST SHAPE

Last Friday's general meeting of the Institution of Mechanical Engineers added considerably to our knowledge of piston rings: how they function, and how they are lubricated. Dr. P. de K. Dykes's paper, based on the results of tests carried out in the Engineering Laboratory at Cambridge University, with the support of the Motor Industry Research Association, using a piston, guided above and below, reciprocating in a fixed cylinder, threw new light on the mechanism of oil loss past pistons. Oil control, it seems, is a two-way problem. Surprisingly large amounts of oil get past even good rings, and the only reason why consumptions remain reasonable in most small engines is that the oil is eventually returned to the sump by the rings later in the cycle. Dr. Dykes refutes the widespread impression that on the down stroke each successive ring scrapes more oil from the cylinder wall until so little is left that the residue can be lost in the exhaust without causing excessive consumption. A ring arrangement giving a good consumption may leave large amounts on the wall after the piston passes downward.

Piston lands, especially the top one, were shown to have an important bearing on consumption. An effective top land will retain oil until it can be returned to the sump by one means or another. If the top land touches the cylinder wall it may scatter this oil and increase the consumption, and a slight taper on the top land has proved beneficial. Oil travels along the same routes, and in company with, the gas leakage. The ring gap is a major route, but the effect of oil leaking down when combustion chamber pressure is high may be more than counterbalanced by upward leakage when cylinder pressure is negative. Oil loss can be caused by oil reaching the wall through the clearance between the groove and the upper surface of the ring, but the extent is influenced by gas forces, ring inertia, and the back clearance of the ring in the groove.

Dr. S. Eilon and Professor O. A. Saunders of Imperial College, London, based their paper on tests with a fixed one-ring piston and reciprocating liner, with means for measuring the instantaneous friction under controlled conditions of piston speed, gas pressure and oil viscosity. Hydrodynamic lubrication prevailed when oil viscosity was low, but as temperature increased, a rapid increase in friction was observed with rise in pressure at the equivalent of top dead centre, indicating breakdown of the oil film and creation of a boundary type of lubrication in this region, equivalent to that where the highest cylinder wear has been commonly experienced.

PARABOLIC PROFILE

Ring width appears to have a direct linear effect on oil film thickness, and as a large proportion of the heat transfer from the piston passes through the top rings, the suggestion is advanced that axial width may be doubled, with a big improvement in piston cooling, for an increase of only 20 per cent. in ring friction. The authors suggest that as rings assume a curved profile in wear, manufacture of rings with a parabolic profile would improve lubrication, and reduce cylinder wear, especially during the running-in period. Formulae are given for calculation of ring width and curvature for known values of viscosity, velocity and pressure. This suggestion is interesting in relation to Dr. Dykes's finding that a square-faced top ring may increase consumption by scattering the oil on the wall during the upward stroke, before it can enter the return routes past the piston.

Letters to the Editor

THE EXPERIMENTAL SPIRIT

SIR, Your contributor, Mr. C. R. H. Simpson, has rendered a very valuable service to the history of mechanical engineering by virtue of the serial article " The Experimental Spirit." I was much interested in his reference to the Southern Railway locomotive No. A816 (ENGINEERING, January 18, page 81), the purpose of which was not merely to save fuel but also to provide a practical approach to a closed-circuit system, with its great potential advantages in prolonging the life of the boiler and in reducing maintenance costs due to scale and corrosion.

The cooler, incorporated in the tank-like vessel alongside the boiler barrel, became the receptacle in which any boiler salts collected, and they could be removed from it quite easily, at the end of a run, in the form of a soft sludge.

The system is, of course, only applicable to engines exhausting normally to atmosphere; in this category locomotives are by far the most numerous class. It was a pity that so much trouble was encountered with the fan, otherwise this very clever idea might well have enjoyed the success it so richly deserved.

In a normal locomotive the blast pipe provides a variable induced draught which depends roughly on how hard the engine is being worked. The greater the demands made upon the locomotive, the stronger the blast becomes, and combustion is stimulated accordingly. Moreover, if, when ascending a bank the boiler pressure drops, the driver's reaction would be to work at a later cut-off; this results in higher back-pressure, and hence a fiercer draught, tending to build up the pressure again.

Hence, the normal locomotive is self-regulating in this respect, in contrast to the " A816 " scheme with a steam or power-driven fan to replace the blast pipe. In that case, if the boiler pressure falls, the performance of the fan falls in sympathy, the one reacting on the other, until a serious state of affairs is reached.

No doubt, if the experiments had been continued, some kind of governing device might have been introduced, to regulate the fan's output inversely with rise or fall in boiler pressure, and this might well have turned the scale, so far as the success of A816 was concerned, for the thermodynamic soundness of the scheme was, I understand, never in doubt.

Yours faithfully,
W. O. SKEAT.

32 Russell-road,
London, W.14.
January 18, 1957.

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BRITISH INSTITUTE OF MANAGEMENT

SIR. The comment in your Weekly Survey note " So Far Not So Good, " in ENGINEERING of January 18, page 71, on the present " stock-taking " at the British Institute of Management, is perfectly valid within its own standards of definition, but it employs, I think, a totally misleading yardstick for measuring the success of the Institute in the years since its foundation.

We are criticised because our " 4,000 members, including 2,000 corporate subscribers " represent " a lamentably small proportion of the professional and practising managers in British industry and commerce," and it is said that " either the Institute has failed to reach them or has been unable to convince them that membership of a professional body can raise their status or provide useful knowledge of management techniques."

The B.I.M. has, in fact, never operated as a professional body in this sense. Out of our individual membership of 4,500, more than 3,000 are students engaged in the B.I.M.-Ministry of Education National Scheme in Management Studies and it is mainly for such people as these that the category exists. It is the 2,000 companies known as corporate subscribers (which are not included in the 4,500) that at present form the core of the Institute. For them, as companies, we provide information on company practice (9,050 inquiries were answered by our information service in the year ended November 30, 1956, which was an increase of 21 per cent. over the previous year) and it is company practice, rather than the advancement of the individual, which forms the subject of our conferences and publications, of our study groups and research projects, and of our executive development programme.

The number of company members is increasing at the rate of about 10 per cent. per annum. It is this figure which we would regard as the most significant. Rightly or wrongly, our efforts at recruitment have been aimed chiefly at this group.

Yours faithfully,
BASIL SAUNDERS,
Press Officer.

British Institute of Management,
8 Hill-street,
London, W.1.
January 24, 1957.

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AGRICULTURAL MACHINERY

SIR, In your interesting article on " Agricultural Machinery," on page 41 of your issue of January 11, you state that complete " systems " of attaching farm implements to tractors are expensive and have not been standardised. In fairness to all, I think it desirable to clear up this point.

When farmers purchase tractors fitted with a three-point linkage (the basis of such a " system") they are under no obligation to use only the equipment specially manufactured for such tractors. All three-point linkage tractors, for instance, are equipped with drawbars so that older, trailed implements may still be used. Moreover, the three-point linkage arrangements themselves fall into two well-defined categories, according to the capabilities of the tractor concerned. The main point to bear in mind is that the farmer will only obtain perfect results from his tractor by using the equipment specially designed for it.

With regard to price, investigation will show that three-point linkage equipment is frequently cheaper than its trailed counterpart, owing to its greater simplicity.

Yours faithfully,
MICHAEL BLOM,
Public Relations Officer.

Massey-Harris-Ferguson,
Eastern Hemisphere Division,
Coventry.
January 22, 1957.

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BARGAINING ON PROFESSIONAL SALARIES

SIR, The Human Element comment " Doctors in the Doldrums," in your issue of January 18, page 96, on the current negotiations between the medical profession and the Government, rightly stresses the wider implications of the attitude which the latter have adopted. You remark that " The Government is clearly as determined to be tough with a professional body as it is weak against trade union pressure," and the reason for this difference in approach is presumably the threat of strike action, implicit if not explicit, which overshadows most negotiations with trade unions to-day.

Faced with this situation, the professions have two alternatives before them if they wish to make any effective resistance to the present continuing deterioration in their relative economic position in the community. Either they must abandon a part of their professional tradition and adopt the same means to secure their ends, or they must find some sanction which offers a satisfactory alternative to the withdrawal of their services. It is worth considering whether such a sanction may not be found in an informed public opinion, but this opinion is largely lacking to-day, so far as the professions are concerned.

For some years, the Guild has held the view that the problems of the professions in this respect are, to a considerable extent, common problems, capable of being solved only by common action, and has been working to this end. The difficulties of establishing any formal link are great, but the time is likely to come—if, indeed, it has not arrived already—when the dangers involved in doing nothing will be infinitely greater.

Yours faithfully,
J. G. ORR,
Secretary.

Engineers' Guild,
78 Buckingham-gate,
London, S.W.1.
January 25, 1957.

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MECHANICAL ENGINEERS' CONTRIBUTION TO CLEAN AIR

SIR, The Institution of Mechanical Engineers is organising a conference on the above subject, which will take place at Central Hall, Westminster, London, S.W.1, on February 19 to 21, next. An introductory lecture is to be given at 7.30 p.m. on February 19 by Sir Ewart Smith, M.A., Vice-President of the Institution and a deputy chairman of Imperial Chemical Industries Limited. His subject will be " Some Technical and Economic Aspects Involved in the Reduction of Air Pollution."

It is hardly necessary for me to emphasise the importance of the subject of cleaning up our atmosphere, to which much public attention has been given during recent years. This conference, however, will break fresh ground, by focusing attention on the vital contribution which mechanical engineers can make towards this desirable end, and the conference is, we believe, the first one of its kind to be held in Britain. The conference is of particular importance, not only to mechanical engineers but also to the general public, for two reasons. Firstly, as mentioned above, mechanical engineers have a special contribution to make towards ensuring a cleaner atmosphere and, secondly, but of no less importance, particularly at the present time, the conference will focus attention on efficient methods of combustion. These two aims of the conference are closely linked together.

Because it is felt that the subject is of very wide interest, the chairman of the conference organising committee, Captain (E) W. Gregson, C.B.E., R.N.R., a Past-President of the Institution, and who is also chairman of the Fuel Efficiency Advisory Committee set up by the former Ministry of Fuel and Power, has asked me to write specially to you, in the hope that you will feel that the matter merits some special mention in your paper.

Yours sincerely,
BRIAN G. ROBBINS,
Secretary.

Institution of Mechanical Engineers,
1 Birdcage-walk,
London, S.W.1.
January 25, 1957.

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Over 100 scholarships are being offered to British students by 17 foreign countries for study abroad during the academic year 1957-58. They are mainly for university graduates and undergraduates, but some are open to others.

The scholarships generally provide for free tuition and maintenance and most of them are tenable for a full academic year, though there are a number of awards for shorter periods. Further information can be obtained from the British Council, 65 Davies-street, London, W.1.

Weekly Survey

Cover Picture: *Sections of aircraft bulkheads are built up in jigs as shown in the illustration. Later they are transferred to larger jigs where the complete units are assembled. The use of jigs enables the required dimensional accuracy to be maintained.*

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Quick Sandys?

The Minister of Defence has lost no time in tackling the first major hurdle in his way to a much reduced defence budget. Last week-end, only a few hours after the Prime Minister had announced the considerable powers granted to him, Mr. Duncan Sandys was in Washington locked in talks with the United States administration. His objectives are clear: to get agreement on lower British military commitments overseas, and to secure the technical assistance necessary for a substantial reduction of expenditure on armaments at home. All this must be done without weakening Britain's ability to resist aggression or the bargaining power of N.A.T.O. countries vis-à-vis the Russian bloc. Mr. Sandys has no more wish to have British National Service men in the Middle East than has Mr. Dulles, though perhaps for different reasons. Britain needs her young men in industry at home, and she needs her savings to invest in plant and machinery with which to compete in world markets. For too long have we tried to compete with our European neighbours on unequal terms. Now the Macmillan Government intend to restore a balance and equality of sacrifice.

The going is not likely to be easy. Mr. Sandys will be a most unpopular man unless he succeeds. It is evident that the price for economic independence will be military dependence. These are political issues, but industrial ones are in their train. The Government have made it clear that they consider the defence expenditure of their predecessors remarkably unproductive. We are still producing conventional armaments in substantial quantities, which would make little impact on the latest weapons available to American and Russian forces. Britain's resources, financial and technical manpower, are inadequate to compete with either country. Research programmes are undermanned and too slow to fructify. The delays between the laboratory and the production line are too great. This is not due to lack of fundamental scientific skills—on the contrary, this country's contribution to basic research has been outstanding in quality. It is due to lack of weight—and yet too much weight has been placed on the side of defence and not enough on the side of competitive trading.

Mr. Sandys has gone to Washington to see if the British defence effort can be made complementary to that of the United States. With guided missiles, which must within a few years replace bombers as well as fighters, the United States are considered two to three years ahead. About to go into service are two " surface-to-air " anti-aircraft missiles, the " Nike Hercules " and the " Talos," both with a range of some 40 miles and speeds of 2,000 m.p.h. Their probable equivalent, developed by English Electric, is unlikely to be in production for 12 to 18 months. A ship-borne anti-aircraft weapon, the " Terrier," has a range of 20 miles and a speed of Mach 2·5. A more advanced version, the " Tartar," has reached production stage. A ground-to-aircraft missile, the " Bumarc," is powered by two ramjets and has a range of 200 miles. In addition, ground-to-ground missiles are being developed with striking ranges of 50, 200, 600, 1,500 and 5,000 miles. Some are already in service.

It is the benefit of these developments that Mr. Sandys is seeking, to strengthen the defence of Britain and to lower its cost. Whether the Government buy the American weapons or acquire licences to make them, a considerable impact on British industry—particularly the aircraft industry—is inevitable. This, perhaps, explains the decision recently announced to pool the industry's resources to develop a supersonic airliner.

The road the Government have chosen, and Mr. Sandys' path in particular, are crowded with obstacles and pitfalls. They would seem, however, to lead in the right direction. In military affairs we cannot be anything but complementary; in industrial affairs—to use words recently spoken by the Chancellor of the Exchequer—" we compete or we are nothing."

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Bank Chairmen and the Engineering Climate

As always at this time of the year, the chairmen of the large joint stock banks have issued their annual statements. Their opinions this year have centred on the future of interest rates and the level of Government expenditure. These are both subjects of vital interest to the engineering industry, for changes in the rate of interest affect the rate of investment by industry in new buildings, plant and equipment, and the level of Government spending is apt to affect the prosperity of the engineering industry more quickly than most. This is because variations in the total outlay of expenditure move these days only in response to defence outlay and the grants made by the central Government to local authorities. The huge mass of welfare expenditure is considered to be a national overhead expense which must be inviolate. In consequence it is the aircraft industry and the building industry which feel quick pressure to expand or contract as Government policy changes.

By and large, the bank chairmen this year have come down in favour of cutting Government expenditure; easing taxation; and adopting a wait-and-see attitude on the interest rates. They are concerned to defend the value of the pound, and most of them would prescribe continuing doses of dear money coupled with reduced Government expenditure to combat continuing inflation for some time to come. Their views on this are all the more significant since bankers are by inclination expansionist in their outlook so far as credit is concerned, however favourably they may view temporary financial restrictions.

When they prepared their speeches they were unaware, of course, that there would be a change of Prime Minister or that Mr. Sandys, the new Defence Minister, would be given unique powers to reduce the burden of arms expenditure without impairing efficiency—no mean directive this. Substantial cuts in defence expenditure may therefore be on the way. How serious these cuts will be remains to be seen. The mountain has given birth to a mole-hill on previous occasions in this context and Mr. Sandys has already said that any reductions " will have to be phased in an orderly fashion over the next few years." Nevertheless there seems to be some prospect of a cut in Government expenditure in the April Budget. If this should bring with it or even be preceded by a reduction in long-term rates of interest there will be a generous stimulus to investment and hence to the engineering industry. The kind of cuts which are coming in Government expenditure suggest, however, that not all sections of the engineering industry will be able to equate lower interest rates with increased prosperity.

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Britannia Services Start

To-day is a happy day for British Overseas Airways Corporation: the " Whispering Giant," the Britannia propeller-turbine air liner, at last goes into service, on the London-Johannesburg route. Once again, B.O.A.C. can offer to their customers on Commonwealth routes a British air-liner that has, at present, no comparable competitor and that will surely prove as attractive to long-distance passengers as the Viscount has on shorter routes.

As is now well known, the Proteus engines of the Britannia have been dogged by " flame-out " troubles—now satisfactorily overcome—encountered in unusual ice-forming conditions. The delay thus occasioned in the Britannia's debut, unfortunate though it has been to the finances and the prestige of the Corporation, should not be considered as time wholly lost. The Britannia starts its commercial life with an accumulation of 5,000 development flying hours, of which more than 1,000 have been utilised for the carriage of troops to the Middle East. Thus the Britannia already has behind it a substantial background of passenger-carrying experience, and there are good grounds for hoping that the aircraft will escape a large proportion of the teething troubles which usually beset commercial aircraft when they start to carry their human cargo.

ENGINEERING's representative has recently had the opportunity of travelling in one of B.O.A.C.'s Britannias, G-ANBE, on a pre-inaugural flight to Zürich and back. G-ANBE is, we understand, the fourth aircraft to be delivered to B.O.A.C. (they now have eight), and is not fitted with additional soundproofing in the forward part of the cabin, as are some of the later machines. No propeller-turbine air-liner can achieve the apparently vibrationless perfection of the jet liner because periodicity is inherent in the conventional four-bladed propeller; but except to the passengers in the front row of seats, who are in direct line with the propeller plane (a bad feature which British aircraft designers should strive to eliminate) the Britannia cabin noise is, nevertheless, quite unobtrusive; and on the Zürich flight it was easily possible to hear a babble of champagne-inspired conversation from several seat-rows distant.

The cabin lighting is good, and permits comfortable reading at night. In flight, the ventilation system appeared excellent to some, although others thought the temperature control was set rather too low. There are four lavatories, which seem reasonably adequate for some 70 people, of which two comprise spacious washrooms, with separate toilet compartment, and are really well-appointed.

The general cabin decor, it must be said, is unadventurous; the serviceable dark blue carpet and upholstery and neutral-coloured walls are not unpleasing, but the curtains, of mediocre quality and uninspired pattern, are not in keeping with the forward-thinking spirit of the airline which pioneered commercial jet-propelled flight.

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Binoculars on Oil Developments

By 1965, in less than eight years, the demand for oil in the world excluding the United States and Soviet bloc countries will amount to 600 million tons. American imports will increase from 60 million tons in 1955 to 165 million tons in 1965. Altogether, therefore, some 750 million tons of oil will have to be extracted from these countries, compared with 350 million tons in 1955. This vast increase in output will require an investment of £14,500 million over the ten years 1956 to 1965. It will be quite impossible to move the oil from the Middle East without using the Suez Canal to an extent greater than ever before. The cost of building round-the-Cape tankers and the lack of capacity and steel to build them, coupled with the absence of suitable unloading ports and dry dock facilities, make Suez a necessity vital to the industrial life of the western hemisphere. Accordingly, great power is vested in the transit countries of the Middle East—Egypt, Syria, Jordan and the Lebanon—since that area will supply 415 million of the 750 million tons needed in 1965.

This rather depressing picture, contrasting in part with the following note, was drawn by Mr. J. P. Berkin, a director of Shell Petroleum, in an address to the Fuel Luncheon Club last month. Mr. Berkin spoke before the Government's plans for an increase in the nuclear

electricity generation programme leaked out into the national Press. It was also delivered before the price of oil from Texan sources shot up in reaction to the growing shortage. Yet Mr. Berkin anticipated a general price increase, especially heavy for fuel oils for which the demand over the past few years has been rising by 15 per cent. per annum compared to 9 per cent. for petrol. His assertion that any expanding industry must find its finance largely from net profits is a bold one, even if this is the traditional method of oil companies. In the United States in recent years only 12 per cent. of total capital requirements had been provided by investors and Mr. Berkin doubts if even this proportion could be raised in other countries. He concludes that the industry's expansion depends " upon its ability to raise funds " and that " if it fails to do so, or is prevented, for whatever reason, then the expanded productive capacity will not be available."

The main sources quoted in this interesting analysis of trends in oil demand and supply are the report of the expert commission set up by O.E.E.C. under the chairmanship of Sir Harold Hartley and the special review published each year by the Chase Manhattan Bank, *Investment Patterns in the World Petroleum Industry, December* 1956. The statistics are unimpeachable, and the reasoning impressively sound. Yet there is a vital question unanswered: how will the " sense of mutual respect and responsibility in international relationship " become established ? For many of the eight years to 1965 oil is likely to be too great a political risk to inspire a great deal of confidence. Atomic insurance is likely to be taken out by the £100 million, and by several of the countries Mr. Berkin includes in his survey.

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Super Tankers and Technical Change

If the thesis is accepted, and it is the official one, that the current oil shortage in this country is basically a tanker shortage, there is ground for satisfaction in the recent trend towards super-tankers. The move towards building tankers of over 50,000 tons was on foot before the Suez crisis but the pace of change has been greatly accelerated. Colonel Nasser will surely rue the day that he challenged western industry to adapt itself rapidly and efficiently to the need to haul Middle East oil round the Cape.

Many companies which ordered medium-sized tankers a year or 18 months ago have changed their specifications towards the super-tanker range. It is apparent that the western world is prepared to go to a good deal of expense and trouble to build big oil carriers and keep them moving efficiently. There are reports of modernisation plans in the shipyards of New England in the United States to build larger ships, and schemes are afoot in this country to handle the new huge vessels now rising on the shipbuilding stocks. The encouraging flexibility of tanker-building plans is one of the less glamorous but significant features of the decision of Mr. Stavros Niarchos to place an order with the Bethlehem Steel Company for a tanker of 106,000 tons for delivery in 1959. His two nearest rivals hope to have 100,000 ton ships available by 1960. The announcement of the building of a new contender for the title of the world's largest oil tanker was made at the launching of a 40,000 ton ship which was considered very large nine months ago when its keel was laid down but which is now much less than half the size of the proposed new vessel. At the moment such a ship could be berthed only at Philadelphia or Rotterdam. Both the Suez and Panama Canals will be too shallow to take her and so will all other European and American terminals. Turbines developing 43,000 h.p. and a speed for the ship of 18 knots are a technical and economic challenge to the near monopoly position of the Suez Canal. This may yet be a classic case of technical innovation being forced forward by political circumstances just short of war.

Agricultural Machinery in 1957

The latest information provided by the Agricultural Engineers Association suggests a rather more optimistic outlook for agricultural machinery in 1957 than was possible a few weeks ago. While the performance of the industry in 1956 was somewhat below that of the previous year the Association consider that very much better figures will be achieved in 1957.

The slight improvement in sales of both tractors and agricultural machinery which took place in the autumn of 1956 was accentuated in November when tractor output was well above the average for 1955. November saw a marked increase in home market sales of both tractors and agricultural machinery, while exports were also above the level of November, 1955.

The full export returns for 1956, published last week, show that, for agricultural machinery, exports at £17·5 million were substantially the same as in 1955. Exports of agricultural tractors, however, showed a decline to £39·7 million compared with £43·9 million in the previous year. There was very little change in the export of individual categories of machinery, though exports of hay and grass mowers have shown a steady increase over the last three years.

The expectation of improved exports for 1957 is based largely on the improvement in the economic and payments position of Australia and New Zealand which, together, took agricultural machinery valued at £3·6 million in 1956. These two countries also imported tractors from the U.K. valued at £7·4 million, but this figure includes some track-laying as well as wheeled agricultural tractors. The Agricultural Engineers Association also considers that there are interesting trade prospects in South American countries.

That there are considerable possibilities in South American markets is shown by the fact that Germany exported agricultural machinery to the Argentine valued at £5·7 million in the first nine months of 1956. British exports to these countries are at present extremely small but there appears to be no intrinsic reason why British manufacturers should not compete on equal terms with their German competitors in these markets. While German manufacturers secured an increasing proportion of total exports to a number of European markets including Belgium, France and Denmark, in South Africa German manufacturers have been losing ground. That an increase in British exports in 1957 will not be achieved without a struggle is, however, shown by the fact that while total German exports in 1956 rose by nearly 18 per cent., the volume of export orders received by German manufacturers exceeded export deliveries by 44 per cent.

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Motor Vehicle Production

The figures for production of motor vehicles in December, 1956, show the effect of petrol rationing superimposed on that of the credit squeeze which had been in operation throughout the year. The weekly output of passenger cars showed a fall of 25·4 per cent. compared with November and was over 40 per cent. below the figure for December, 1955. In the case of commercial and public-service vehicles the corresponding figures were 17·5 per cent. and 35·9 respectively. These figures reflect a fall in both home and export demand, though insofar as exports of private cars fell by only 19 per cent. and of commercial vehicles by 25 per cent., it is clear that the main influence has been reduced purchases in the home market. The relaxation of hire purchase restrictions is stated to have had no significant effect on sales of new cars in the home market in December, but the first weeks of the new year have seen a marked increase. It has also created a bigger demand for secondhand cars with a corresponding increase in prices.

The petrol shortage in Europe has also been reflected in the output of the German industry. Although for the year 1956 as a whole German output of private cars and commercial vehicles, at 1,073,084 units, was a record, the output in December showed a decline of 15·2 per cent. compared with November and of 4·4 per cent. compared with December, 1955. This was the first time that output has fallen compared with the corresponding month of the previous year since February, 1952. The decline in output in December was primarily due to falling demand and the percentage of output accounted for by exports rose to 48·5 per cent. compared with 45·2 per cent. for 1956 as a whole.

These figures presage an intensified competition in export markets as German home demand declines, and draw attention to the difficulties facing the British Government in its dealings with the British motor industry. If production continues to fall, costs must rise and the industry will be at an increasing disadvantage in export markets: on the other hand, if home sales are stimulated and exports fail to recover, the industry will increase its demands on the country's resources of materials and labour which might be more usefully employed elsewhere.

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Diesel Oil Problem

The rationing of petrol and fuel oil has highlighted the tendency that has existed for some while but become more marked in recent years, and that is the enormous increase in the use of the middle distillates from crude oil. It has been reported indeed, that at the present time, quantities of petrol are far greater than are required by the rationing system, but oil for Diesel engines and for fuel purposes has fallen even below the estimated figures. This raises a problem for the oil companies which could be solved in normal times by the addition of increased refinery capacity in this country—an extremely expensive operation. This situation applies, however, not only in the United Kingdom but to all countries throughout the world.

In 1938 petrol represented 49 per cent. of Europe's inland consumption of oil, but is now only 28 per cent. The demand for kerosines, gas and Diesel oils has risen from 17 to 27 per cent. during the same time. European road users consume one ton of " derv " for every two and a half tons of petrol. In the United Kingdom this figure is only one to four as yet, but as elsewhere is increasing yearly. Every ton of crude oil yields a certain quantity of middle distillates and the quantity cannot be increased at all easily. A note for the manufacturers of Diesel engines, therefore, would seem to be to make the engines of the future flexible enough to take a wider range of distillates than are included in the present-day Diesel oil. In this way, the demand could be spread more evenly over the distillate fractions as obtained from crudes. Many marine engines already use heavy oils and the tendency for this is increasing. To what extent it can or will be applied to smaller high-speed engines is a factor that depends on design and availability.

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Craftsmen—Profits and Expansion

The national embargo on overtime working by maintenance craftsmen in the steel industry cost the Steel Company of Wales 200,000 ingot tons of output and nearly £3 million of profits in the year ending September 29, 1956. Trading profit before depreciation fell from £18·3 million to £14·2 million. The other £1 million was accounted for by cost increases during 1956. Wage rates increased by ten shillings a week, freight charges increased by 5 per cent., and coal prices by 6 per cent. The Company's chairman, Mr. Harold Peake, expressed his disappointment with the financial results " in a year during which excellent progress has continued to be made with development work." He gave details of the company's third development plan due for completion towards the end of 1959:

annual production will be raised from 2·4 to 3·0 million tons of steel ingots and rolled production capacity expanded by the installation of a new 4-stand cold reduction mill to process light-gauge sheet. Total expenditure is estimated at £50 million, compared with £54 million for the second development plan.

Mr. Peake views the prospects of the company with confidence, despite the "far-reaching" economic consequences of the blocking of the Suez Canal which has led to a reduction in the demand for sheet. Mentioning that the increases in maximum steel prices announced in December will bring "some relief" from increased costs, Mr. Peake underlines the fact that "the increases do not take into account any of the effects of the closing of the Suez Canal." He does not, however, give support to Mr. Chetwynd Talbot of South Durham Steel and Iron Company, who suggested last month that the pricing policy of the industry "was due for a major overhaul": "I consider it would be in the interests of both the consumers of steel products and the steel industry if a wider approach to the subject of fixation of steel prices is considered on lines similar to the formula operated in the United States over a long period of years."

Few would question the industry's need for a good profit margin to build up the reserves necessary for expansion although, as the recent rights issue by United Steel has shown, there is no lack of support in the capital markets for the leading concern in the industry. Most would agree with Sir Ernest Lever, chairman of Richard Thomas and Baldwins, that "taking everything into account, the iron and steel industry must increase its manufacturing capacity if future demand is to be met." The need is urgent.

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Shortages of Materials and Cash

Higher output and turnover in increasingly competitive markets is the keynote of a long speech by Lord Brabazon of Tara, chairman of Associated Commercial Vehicles, Limited, to the company shareholders at their 45th annual general meeting. The demand for heavy lorries has been good, both at home and overseas. A.C.V.'s turnover for the year ending September 30 was £2 million higher than the previous year and may have been higher still but for shortages of skilled labour, alloy steel and certain types of drop forgings. Lord Brabazon was critical of the world shortage of nickel which he described as "a serious threat" to the production of crankshafts, gears and axle sha , and therefore to his company's progress.

One of the main themes running through Lord Brabazon's speech was the developing shortage of capital due to the impossibility, because of the high rate of tax, of ploughing back into the business enough to replace plant and to finance an expanding turnover. Many have said the same—in fact, it is usual to hear that heads of commercially successful expanding concerns spend most of their time and energy trying to keep their companies solvent. Lord Brabazon, speaking as he was in the "budget making" season, was doubtless addressing himself to the new Chancellor. From statements heard so far he was preaching to the converted, for few governments have made it clearer that they intend to encourage investment in modern plant and processes. Yet it is doubtful if even the most generous Chancellor could give A.C.V. all they need. Their high expenditure on new plant—fixed assets rose by £600,000 during the year—was dwarfed by the rise in the value of stocks and work in progress, by £3 million to £10·8 million.

Some of the reasons for this increase, which in A.C.V.'s case is the main burden in liquidity, have already been mentioned. Shortages of certain alloys have resulted in unbalanced stocks. The shortage of skilled labour has held down production rates. But another reason, arising from increasing competition, is the need for off-the-shelf delivery of spares to make possible an efficient after-sales service. This is a price companies will increasingly have to pay.

The late Dr. Franz Lang

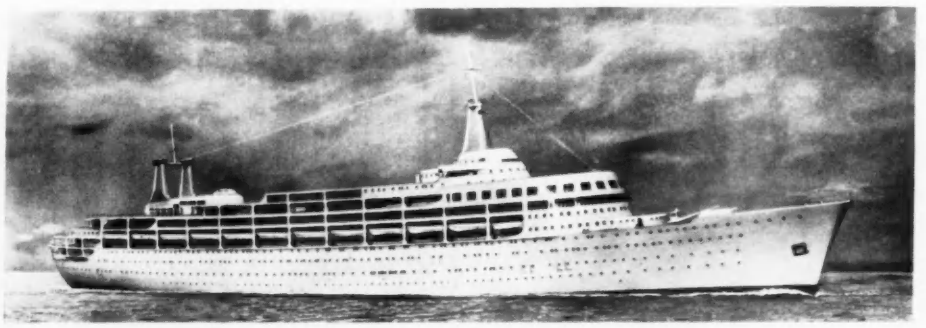
Those engineers who have followed the development of high-speed oil engines will learn with regret of the death on December 16, last, of Franz Lang at the age of 83; those who had the good fortune to know him will have memories of a gifted engineer and a most kindly man.

A Bavarian by birth, at an early stage in his career he joined the company at Nuremberg later known as the M.A.N., and when that organisation took over the inventions of Rudolf Diesel he was chosen for his practical understanding of engines as Diesel's assistant on the test-bed. His keenness, energy and practical talent were highly valued by Diesel himself whose own approach was essentially academic. Lang, however, was from the beginning a partisan of the direct injection of fuel into the working chamber and although, with Diesel and after the latter's death, he was concerned at the works with larger engines with air injection, in his private workshop he was busy as early as 1910 with direct injection on very small engines.

In order to concentrate on his inventions Lang left the M.A.N. Company in 1922 and, with the brothers Wielich, set up the Süddeutsche Motoren, A.G., in Munich as well as the Acro A.G. in Switzerland. He was occupied there with fuel pumps and nozzles and developed the Acro combustion chamber which, incidentally, was named after one of the firms, the American Crude Oil Motor Corporation. In 1925 Lang and his 180 patents were transferred to the Robert Bosch Company of Stuttgart, and there formed the basis of the world-wide activities of that company in injection equipment. In those early days, too, several companies took licences for the Acro combustion chamber.

After 1½ years with the Bosch Company, Lang returned to Munich and in his laboratory there developed the Lanova combustion chamber, now embodied in the engines of, among others, Henschel of Cassel, Panhard et Levassor of Paris and Allis-Chalmers-Buda and the Continental Motor Corporation in the U.S.A. His stepson, Dr. Heinrich Lang, continues the work.

Franz Lang's 75th birthday was marked by a special celebration at the Deutsches Museum, Munich, at which he was made an Honorary Member of the Verein deutscher Ingenieure. Two years later the Technische Hochschule of Munich conferred on him its honorary doctorate in technical sciences (Dr.-Ing.). Lang enjoyed good health and was active in his laboratory until the last months of his life.



The largest British liner since the Queen Elizabeth, "Number 1621" will be driven by turbo-electric machinery of 85,000 s.h.p. at a service speed of 27½ knots.

ANOTHER MACHINERY-AFT LINER

"A pledge for the future" might be a description of the new 45,000 ton liner that has been ordered by the Peninsular and Oriental Steam Navigation Company for service to Australia and Vancouver. The new vessel is designed for first and tourist class only, having in mind the probable continuation of the flow of immigrants to Australia, and also with the knowledge that both the Strathaird and the Strathnaver will be approaching the end of their useful lives in the 1960's. "Number 1621" (as yet she has no name) will thus be larger than the Orient liner Oriana with whom she will share the Vancouver trade.

In planning ahead, the P. and O. recognised that there should be a general increase in service speed, and the new vessel is therefore designed to run at about 27½ knots as against 22 to 22½ knots for the Arcadia. This would reduce the voyage to Australia by approximately one week. The choice of a vessel of this size as against smaller ones was based both on initial cost and economical running. Two 45,000 ton ships are equivalent in work value to three smaller ones of the size of the Iberia and Arcadia; would involve less expense in the yards and smaller operating and maintenance costs. The order for the new vessel has been placed with Harland and Wolff, Limited, of Belfast, and the keel will probably be laid in September of this year; it is expected that the ship will enter service towards the end of 1960.

Following one or two vessels of recent years (notably the Shaw-Saville Southern Cross, some notes on which were recorded in ENGINEERING, vol. 180, page 673, 1955) the main propelling machinery will be placed aft, and the design of the vessel will consequently be considerably improved by this arrangement. There will be thirteen decks, and she will carry a total complement of 3,210, of which 600 will be first class, 1,650 tourist class and 960 crew. That is to say, she will carry more passengers than the Queen Elizabeth. There will be three cargo holds at the forward end, totalling 1,500 cub. ft. The two aftermost of the three holds will be loaded through the ship's side: one is especially designed to accommodate cars. The amount of cargo space is somewhat less than in other vessels of the fleet, and has been chosen to give a quick turn-round in ports for economical operation. The vessel will be of welded construction generally, and the greater part of the superstructure will be of aluminium, also welded. Accommodation will include swimming pools, library, writing rooms and the like.

Unusual for a ship of this size, the main propelling machinery, for which an order has been placed with the British Thomson-Houston Company Limited, will be turbo-electric, developing about 85,000 s.h.p. as a maximum. Oil-fired boilers will supply two single-stage turbines operating at 700 lb. per sq. in. at 950 deg. F. to drive the main alternators, and these, through control gear, will drive the motors for the two screws. Running on one set only, the vessel can still maintain a speed of approximately 23 knots. A provisional figure for her range without re-fuelling is 10,000 miles. Another unusual feature is that all the auxiliaries will be driven from alternating-current supplies. Four turbo-alternators each of 1,500 kW, 440 volts, 3 phase, 50 cycles, will generate the power. Two sets of Denny-Brown stabilisers will be included.

Approximate dimensions of the new vessel are 814 ft. overall and 740 ft. between perpendiculars, beam 102 ft. load draft 31 ft. 6 in. and height from load draft to navigating bridge 90 ft. Air conditioning will be installed throughout.

PRODUCING DEEP PRESSINGS

FIVE-STAGE TRANSFER-FEED PRESS

The horizontal five-stage transfer-feed press illustrated herewith is the latest addition to the range of presses made by Taylor and Challen, Limited, Derwent Works, Birmingham, 19. As shown in the illustrations the press is equipped with tools for five-stage drawing of copper "shells" approximately $\frac{5}{8}$ in. outside diameter by 2 in. long from annealed cups 1 $\frac{1}{16}$ in. in diameter by $\frac{3}{4}$ in. deep, but the principle is, of course, adaptable to multi-stage work on any components of similar type. Presses are, in fact, being built to produce a larger shell in steel, and to perform second-operation work on drawn components. Developments such as strip feeding and hopper feeding of cups and other components are under consideration.

The press illustrated is fed with cups by hand, the components being pushed on to a turntable or "skid-plate," which carries them to a feed chute. Entering the chute in single file, the cups fall down to an escape movement, which permits only one cup to leave at a time, and to do so only when the first cradle of a transfer carrier is in the correct position to receive it. The feed chute automatically rejects any cups which have been put in the wrong way round. When the cup is in position the cradle moves horizontally to bring the component in front of and concentric with, the first die. In this position the cup is ready to receive its first drawing operation, and the first punch moves forward. As the punch enters the cup to push it into the die, the cradle carrier moves downwards far enough to enable the cradle to clear the underside of the punch. The carrier then moves back to its loading position and rises once more to its original height. In rising, the last part of the vertical movement of the cradle carrier operates a trip which allows another cup to fall into the first cradle. A spring-loaded flap, opened by a cam, is provided on this cradle, the flap closing on the cup when the carrier moves sideways. The cup is thus held securely until it is pushed into the die by the punch. There are five cradles mounted on the carrier, at centres matching those of the punches and dies, and there is therefore a cradle waiting at each stage to receive a drawn component and carry it to the next stage. The cradles, which are machined to suit the component at each stage, are easily replaced when re-tooling.

A top guide bar covers all the cradles except the first one, and leaf springs ensure that the components are presented correctly to the dies. The punches, which pass through stripper bushes housed in a stripper bridge at the rear of the carrier, are so adjusted that the shell is never drawn beyond the parallel portion of the die. If the shell comes out of the die with the returning punch it is stripped off into the cradle. If, on the other hand, it tends to remain in the die, it is dealt with by a back ejector, one of which is provided at each stage.

The transfer motions are operated by cams on a shaft driven from the main crankshaft, and the same camshaft also drives the feed turntable and a coolant pump. Coolant is fed to two manifolds, one above the dies and the other over the punches, but behind the stripper bridge. Each manifold has five taps, so that coolant flow can be adjusted independently at each drawing stage. Both manifolds are hinged to lift upwards for access to the tools for minor adjustments, and both are easily removed.

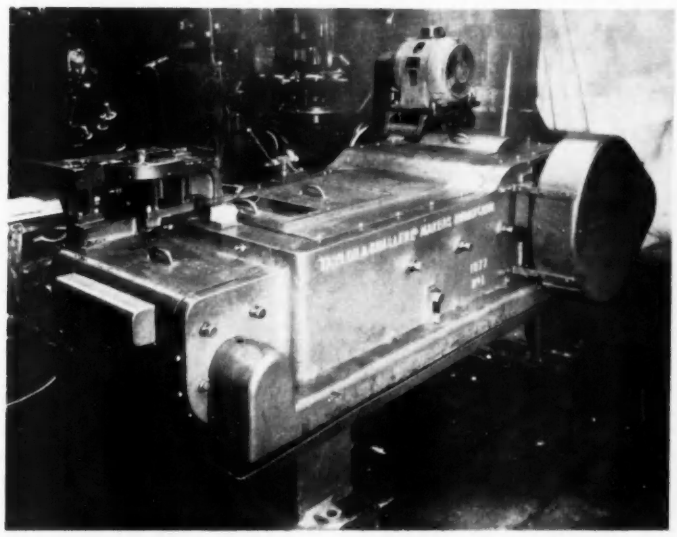


Fig. 1 The Taylor and Challen horizontal transfer-feed press has five stations. It is totally enclosed, with a hinged cover over the tooling area, interlocked with the driving motor.

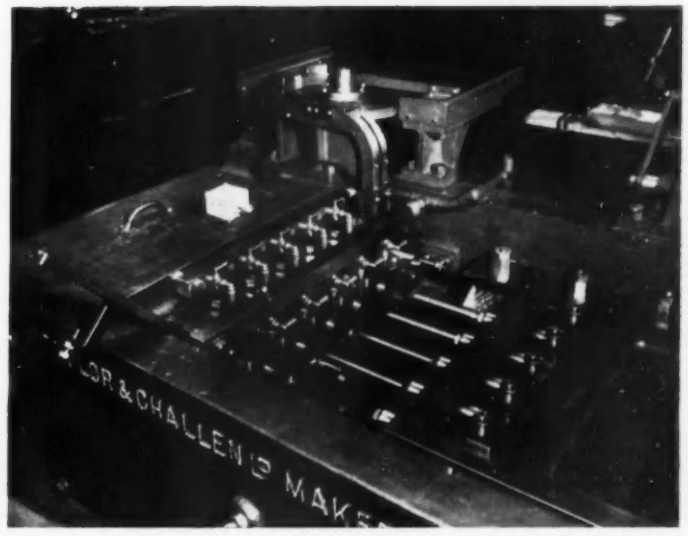


Fig. 2 With the guards removed the tools are easily accessible for adjustment or for re-tooling. The tooling area is visible through a Perspex window when the guards are closed.

CRANK AND CAM DRIVES

The main slide of the press runs in V-guides, and is driven by a two-throw crankshaft, giving it a stroke of 10 in. Five individually-adjustable punch holders are mounted on the slide, each one having a maximum adjustment of $\frac{1}{2}$ in. The dies are carried in a steel die bolster bolted to the press frame, and machined to accommodate the dies, each of which is easily removed. Behind the dies there is the back ejector slide, which also runs in double V-guides, and has a 2$\frac{1}{4}$ in. stroke, its motion being derived from a cam on the main crankshaft. Each ejector bar is individually adjustable, and all have split taper collets and nuts for holding the ejector pegs.

The main frame of the press is a one-piece iron casting mounted on stands which also support the coolant tray. A 7$\frac{1}{2}$ h.p. squirrel cage electric motor, running at 960 r.p.m., is mounted at the crankshaft end of the frame, and this drives the press at 60 strokes a minute through V-belts, a clutch and gearing.

The clutch is of new design. It is of the multi-plate, dry type, having four plates faced with friction material and five plates of high-carbon steel. The friction material is sintered bronze, $\frac{3}{64}$ in. thick, sintered on each side of the $\frac{1}{16}$ in. thick steel plates. The friction plates were made specially by Sintered Products, Limited, Sutton-in-Ashfield, Nottinghamshire, and supplied through Small and Parkes, Limited, Hendham Vale Works, Manchester, 9.

A control handle mounted near the loading table is connected to the clutch by toggle gear, and also operates a band brake on the pinion shaft. Provision has been made for easy adjustment of the clutch plates without affecting the initial setting of the toggles and linkage. A hand brake-release is provided for use when tool-setting. This locks the control gear in a safe position and makes it possible for the press to be inched by means of a handwheel on the pinion shaft. The top of the handwheel is just visible in the illustration of the complete machine, to the left of and a little below the main driving motor, and it will be obvious that a tool-setter can turn this handwheel while observing the tools, which are located in front of the control handle visible in the centre of the illustration.

The press is adequately guarded; it is, in fact, totally enclosed, as can be seen from the illustration of the complete machine. A Perspex window in the sheet steel guard over the tool area enables the operation of the press to be observed at any time in safety. This panel is hinged to allow access to the tools for adjustment purposes, and a limit switch cuts out the driving motor immediately the panel is opened.

The tools on the press illustrated are spaced at 3$\frac{1}{2}$ in. centres. This allows for dies with tungsten-carbide inserts to be used, and gives space for sufficient support on the largest die in the series, that is, the first one. On the basis of this spacing the press is approximately 8 ft. 11 in. long and 5 ft. wide, with a working table height of 40 in. The overall height for clearance purposes (over the driving motor), is 5 ft. As mentioned earlier, presses are now under construction for other duties, and this will involve some change in size. A machine for dealing with a larger component in steel, for example, has its punch and die centres increased to 5 in., with a consequent increase in size.

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WATT MEDAL FOR GERMAN

The Council of the Institution of Mechanical Engineers have awarded the James Watt International Medal for 1957 to Professor Dr. Ing. Walther Bauersfeld, of Zeiss-Werke, Germany, in recognition of his work as a scientist, inventor, and successful organiser, particularly in the application of precision engineering in the field of optics. Professor Bauersfeld is arranging to come to London early in May to receive the medal at the Institution's headquarters at 1 Birdcage-walk, London, S.W.1. He will also deliver a lecture bearing on his work.

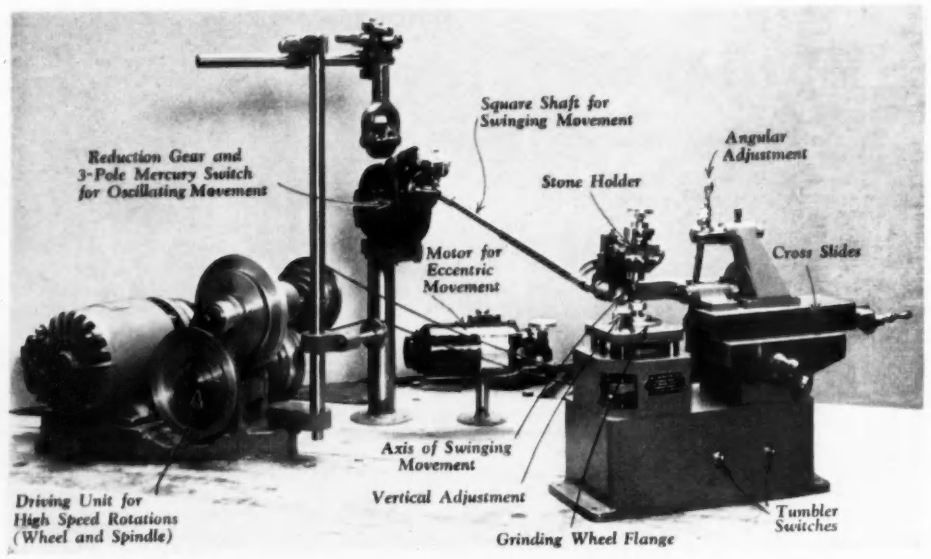

Square Shaft for Swinging Movement
Reduction Gear and 3-Pole Mercury Switch for Oscillating Movement
Angular Adjustment
Stone Holder
Motor for Eccentric Movement
Cross Slides
Axis of Swinging Movement
Vertical Adjustment
Driving Unit for High Speed Rotations (Wheel and Spindle)
Grinding Wheel Flange
Tumbler Switches

Fig. 1 Machine for grinding conical and spherical surfaces on diamonds.

DIAMOND TOOL MANUFACTURE

FORMING CONICAL AND SPHERICAL SURFACES

By P. Grodzinski, DR. ING., M.I.MECH.E.

The engineering visitor to a diamond-polishing works will usually comment on the old-fashioned appearance of the equipment; to which his guide will retort that, nevertheless, it is surprisingly efficient. Both statements are generally true. The technique of rotating a relatively heavy spindle about a vertical axis at more than 2,000 r.p.m. is no mean achievement to have been accomplished several hundred years ago. The wooden pivot or point bearing is very effective, as only a minimum of friction is caused; and the long belt drive absorbs vibration.

Numerous attempts have been made to improve this equipment, from those of the French engineer Philippe in 1858 and of Sir Henry Bessemer* in 1885 down to modern developments during the 1940's.† The main aim in gem polishing, and also in the preparation of industrial stones, was to polish flat faces; but, with the advent of the Rockwell hardness-testing machine cone and other special shapes, there is an increased interest to-day in conical and spherical surfaces, which should have a surface finish equal to that achieved on flat surfaces. The intrinsic difficulty in producing such a finish lies in the structure of the diamond; in a plane which is symmetrical with the body of the stone or about its crystal axis, this structure is subject to critical changes when attempts are made to form, for example, a sphere or a cone.‡

The new machine§ described below has been designed to permit of the grinding of accurately conical and spherical surfaces. As can be seen from Fig. 1, the main part of the machine is a grinding-wheel carrier, provided with a fine vertical adjustment. The spindle, mounted in plain bearings, is fitted with a metal-bonded diamond cup wheel, 3 in. in diameter and with a rim $\frac{3}{4}$ in. wide, and is driven by an electric motor provided by Pultra Limited, Salford, which can run at six different speeds; the usual speed, however, is 4,500 r.p.m. The spindle is carried in an eccentric sleeve which itself is rotated at 20 to 30 r.p.m. by a separate low-speed fractional horse-power motor, the speed being controlled by a resistance built into the motor unit. By this means each point in the plane of the grinding wheel performs an eccentric movement of $\frac{3}{16}$ in. radius (Fig. 2).

The stone-holder is adjustable in relation to the grinding wheel, and has to perform swinging movements for the generation of cones and spheres. It is mounted on a cross slide so as to allow movement over the whole wheel surface, covering at least a full quadrant, in order to overcome the effect of the grain of the diamond. The top slide carries the bearing for a bracket which can be adjusted at different angles above and below the plane of the grinding wheel; this adjustment can be read on a protractor. A bearing on this holder, at right angles to the base bearing, carries the swinging tool-holder, the setting of which is also indicated on a protractor; and the tool-holder is movable axially along two bars, to which it can be clamped. The diameter of the tool-holder is comparatively large, namely, $\frac{1}{16}$ in., the tool to be ground being carried in a small mount $\frac{1}{8}$ in. square. A depth adjustment is provided by a ring which can be clamped on to the cylindrical bar. The angular position of the bracket in relation to the plane of the wheel determines the angle of the cone that is to be ground.

The swinging movement of the tool-holder is effected by a fractional horse-power motor, driving through spur gears and having two armature windings. The drive is transmitted by a telescopic shaft and two universal joints, so that the angle of the bracket can be changed while the motor remains fixed. The automatic swinging movement is obtained by a three-pole mercury switch, mounted as a pendulum, the two outside poles being connected with the alternative armature windings. Two tripping fingers on the shaft bring the mercury switch into the two limiting positions, causing reversal of the motor, as shown in Fig. 3.

When spheres are to be generated, the stationary quill is replaced by a rotary quill, the spindle running in two adjustable magneto-type bearings. A pulley fixed to the spindle is driven by an endless belt from the upper jockey pulley of the driving unit.

A few additional features may be mentioned. The square socket for the tool-holder is held by two angular pieces, so that difficulties in centring are avoided (Fig. 4). All the drives are by round polyvinyl chloride belts of Swiss manu-

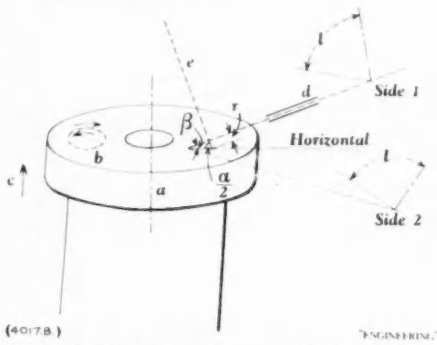


Fig. 2 Schematic arrangement of movements of machine shown in Fig. 1.

a Grinding wheel; speed of rotation 4,500 r.p.m.
b Auxiliary eccentric movement of grinding wheel, radius $\frac{3}{16}$ in., speed 20 to 30 r.p.m.
c Vertical feed of grinding wheel against a fixed stop to avoid oval grinding.
d Axis about which the holder for a double-cone diamond performs oscillating movements of constant angular velocity, which contains:
e Holder $\frac{1}{16}$ in. diameter, adjusting angle $\beta = \frac{180 - \alpha}{2}$, with α included angle of double cone. In standard type $\alpha = 154$ deg.
l Swinging angle.
r Radius of double cone. In standard type, $r = 2$ mm.

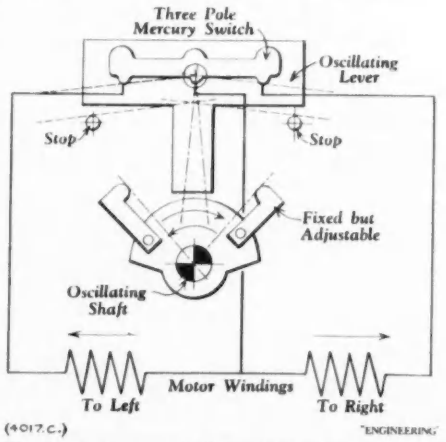


Fig. 3 Arrangement of three-pole mercury switch to produce a swinging movement of approximately uniform angular velocity.

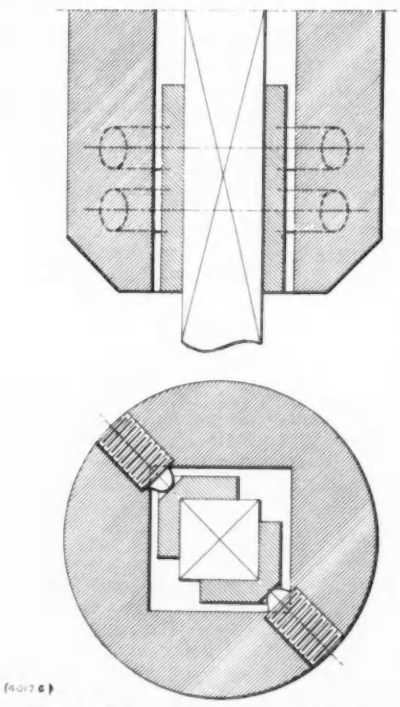


Fig. 4 Square inserts and centring device.

* ENGINEERING, vol. 47, page 123 (1889).

† *Diamond Tool Patents* IV, "Polishing of Gem Diamonds," by W. Jacobsohn, Industrial Diamond Information Bureau, December, 1950.

‡ *Diamond Technology*, by P. Grodzinski, N.A.G. Press, Ltd., London (1953).

§ Produced by W. J. Wooster, Ltd., 2 Eskdale-road, The Trading Estate, Uxbridge, Middlesex, and for which British Patent 767175 has been granted to Industrial Distributors (Sales), Ltd.

facture, which can be joined easily under heat; after an initial period of stretching they run for a long time without special attention.

Double cones can be ground on the machine* either by indexing the tool-holder 180 deg. (the method originally employed) or by bringing the inclined axis beneath the grinding plane, as shown in Fig. 2. In this way only the angular adjustment of the bracket requires to be changed, the tool-holder remaining fixed in place. With the same arrangement, four-sided pyramids can be ground without indexing by using both the inclination of the bracket and the swinging angle, which intersect at 90 deg. The swinging movement should be approximately uniform over the full swinging angle. A movement by a simple crank (a four-bar link) was found unsatisfactory until it had been extended to a six-bar link of special design.* Later, however, a co-axial drive directly from a motor with a spur reduction gear was found to be more adequate.

* Brit. Pat. No. 651,800, "Experiences with the Double-Cone Indenter," by P. Grodzinski (paper presented to the First British Hardness-Testing Conference, Sheffield, October, 1953).

* "Neue Getriebe mit konstanter Geschwindigkeit während des Hubes," by P. Grodzinski; paper presented at the First V.D.I. Conference on Mechanisms, Berlin, October, 1951, and published in *V.D.I. Tagungsheft*, 1 (1953).

TOWN GAS USED IN PRODUCTION

To demonstrate to industry generally the contribution that the gas industry is making to production needs, four area gas boards—North Thames, South Eastern, Southern, and Eastern—have organised an exhibition depicting "Gas at Work in Industry," which has been in progress at the Royal Horticultural Hall, Westminster, London, S.W.1, for the past nine days and which closes to-morrow. More than 70 manufacturers are taking part in the exhibition, which covers a diverse range of applications—hot water supplies, catering equipment, space heating, convection heating and infra-red radiant heating ovens, high-temperature radiant heating, metal melting, shell moulding, liquid heating tanks for cleansing and degreasing, burners and small appliances, flame processing, glass working, heat treatment furnaces, instruments and controls, and incineration.

Among the exhibits of interest in the flame-processing section is the Beagle transportable oxygen profile-cutting machine shown by British Oxygen Gases, Limited, capable of making one-off cuts in mild steel up to 2 in. in thickness, and of describing both bevel and square-edge cuts in any direction within the cutting area. Surfard Limited, Abbey House, Victoria-street, London, S.W.1, are demonstrating a Peddinghaus automatic oxy/town-gas flame-hardening machine, for which they are the sole concessionnaires in the United Kingdom. This machine, shown in the accompanying illustration, has been designed for hardening steel or cast-iron camshafts, but is suitable also for many other components which require hardening in specific areas; the components pass through four positions—loading, heating, quenching and unloading. When the required temperature is attained, the component being treated is automatically advanced to the next station.

In the heat-treatment section there is the largest single piece of gas-fired equipment on view, a 200 lb. new horizontal sealed quench furnace shown by Birlec Limited, Tyburn-road, Erdington, Birmingham. Shown in the second illustration, it is suitable for carbonitriding, gas carburising, bright hardening, clean normalising, and carbon restoration. An unusual feature of the new furnace is that it provides for direct quenching of the work while preserving intact the protective atmosphere round the heated material, the work being drawn from the heat-treatment chamber into a vestibule charged with the protective atmosphere, whence it is lowered directly into the quench tank. Other furnaces in the same range have capacities of 650 lb. and 1,400 lb.

Gas in the manufacture of electric lamps is featured by the General Electric Company Limited, Kingsway, London, W.C.2, who are demonstrating a gas-heated miniature bulb-blowing machine for flashlamps, and a machine for making the glass flange, inside an electric lamp, which contains the wires leading to the filament.

A "do-it-yourself" opportunity is provided by F. J. Ballard and Company Limited, Tividale, Tipton, Staffordshire, who are operating a camel-back conveyor oven with hand-dip and spray-painting facilities which they are making available to visitors who wish to carry out sample tests under actual production conditions. The installation is suitable for any drying, curing or low-temperature heat treatment work from 100 deg. to 650 deg. F.

Gas for all the equipment demonstrated at the exhibition has been provided by a motor-driven gas booster installed for the purpose in the basement of the Royal Horticultural Hall, handling 8,000 cub. ft. of gas per hour. The booster is supplied by Keith Blackman, Limited, Mill Mead-road, Tottenham, London, N.17.

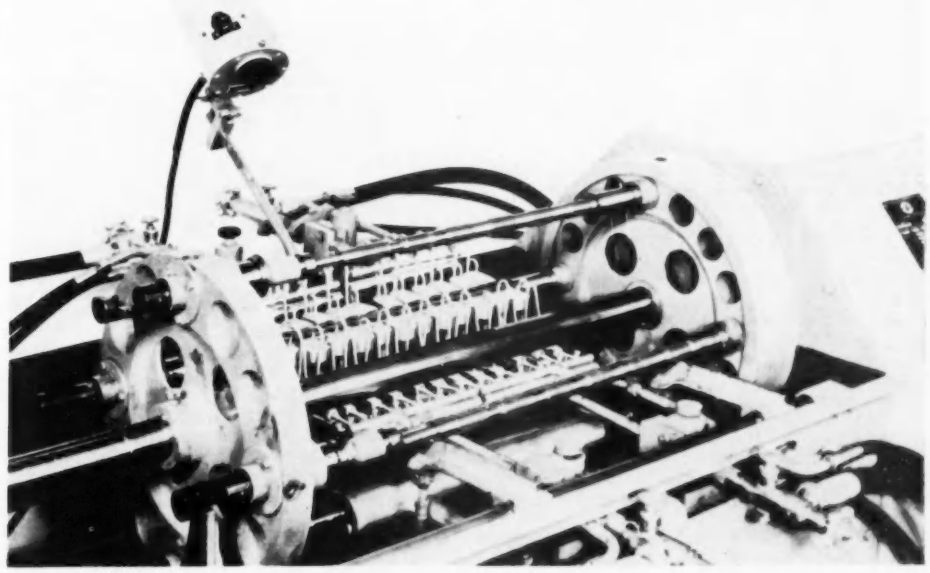
Indicating, recording and controlling instruments for temperature measurements between — 200 deg. C. and 2,000 deg. C. are being shown by Elliott Brothers (London), Limited, Century Works, Lewisham, London, S.E.13. The Series 500 range of recording and controlling instruments is represented by a 12 in. model for use with expansion-type sensing elements for measurements up to 550 deg. C. These recorders provide permanent, evidence of temperature conditions and fluctuations, and can be fitted with clockwork or electrical chart drives with a wide range of chart speeds. For control applications, they can be supplied as combined controller-recorders with either air-operated three-term control or electrical on-off control.

For temperatures up to a maximum of 2,000 deg. C., electrical temperature-sensing elements are shown with both electronic self-balancing potentiometer and direct-deflection instruments. Also displayed is the Elliott CO_2 metering equipment which comprises analysers of the thermal-conductivity type. The equipment provides continuous and direct reading of gas analysis from flues, thus giving a measure of the efficiency of combustion.

A range of gas-fired incinerators and an industrial air heater are exhibited by Wm. Sugg, Limited, 67-73 Regency-street, Westminster, S.W.1. The incinerators are of two types, the wall-mounted "insert" model and the pedestal model. The simple action of opening the door lights the main burner from a pilot jet. An automatic timing device is fitted which can cut off the gas after a burning period ranging from 3 to 120 minutes as required, the usual time, however, being only 10 minutes. The gas rating for either model is 12·5 cub. ft. per hour.

The air heater on display is the "Halcyon" W2/45. This is a convector heater in which the movement of air through the heating surfaces is assisted by a silent electric fan. It is normally fitted on the wall, approximately 6 ft. from the floor, and may be installed either in the room to be heated or fitted with standard duct components and sited in an adjoining room. The unit may also be used for the circulation of fresh air only.

200 lb. sealed quench furnace (Birlec Ltd.).



Automatic flame hardening machine (Surfard Ltd.).

AUTOMATIC FAULT DETECTION IN ROTOR FORGINGS

An automatic method of testing rotor forgings for internal faults, using a Solus-Schall ultrasonic flaw detector in conjunction with a monitor, is being investigated by the General Electric Company, Limited.

The rotor is mounted in a lathe with the probe of the flaw detector carried in the tool rest, as shown in the illustration. As the rotor is slowly revolved, the probe traverses its full length. Any internal fault causes a light to appear on the monitor and the attendant marks its position on the forging. Alternatively, provision is made for an audible warning to be given. Any faults discovered by this preliminary scanning are subsequently explored fully by hand methods to establish their precise nature. In addition to the advantage of complete coverage, the operator's efficiency is improved, since he is relieved of the strain of continuously watching a trace on a cathode-ray tube. Furthermore the time necessary to conduct a full examination of the forging is reduced very considerably.

A further development of this system, now being considered, is the provision of electronic apparatus to mark any rotor fault automatically, removing the need for an operator in constant attendance. It is expected that this will lead to an increase in scanning speed.

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OXYGEN IN THE OPEN-HEARTH PROCESS

Metallurgists and steelworks engineers will be interested to learn that the Steel Company of Wales Limited, Abbey Works, Port Talbot, Glamorgan, have concluded an agreement in connection with the P.T. oxygen gun with Kaiser Engineers, Oakland, California, U.S.A.

The agreement grants to the American firm the right to make, use, sell and sub-license, to other firms, the oxygen gun equipment which has been patented in this country by the Steel Company of Wales. The rights granted to Kaiser Engineers apply throughout the world with the exception of Europe. The P.T. oxygen gun has been developed by the Steel Company of Wales for use in the rapid elimination of carbon in the open-hearth furnace. It is mounted vertically through a central hole in the furnace roof and causes a jet of oxygen to impinge on to the surface of the molten steel. It is particularly suitable for large open-hearth shops having fixed furnaces and ground charging machines and is in regular use on all the furnaces in the Abbey Works steel melting shop at Margam.

The advantages of the gun over other methods are numerous. In particular, its operation can be fully mechanised and, in addition, there is no interference with charging or tapping operations. Upwards of 60,000 cub. ft. of oxygen per hour can be delivered to the furnace, greatly increasing the rate of carbon removal in the somewhat difficult lower-carbon ranges. The consequent decrease in the "tap" to "tap" time considerably increases the production of steel.

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TENSILE TESTING OF METALS

First introduced in June, 1904 for the purpose of eliminating unnecessary variations in tensile testing requirements, British Standard 18 covering the "Tensile Testing of Metals," has since been revised four times, namely, in 1907, 1910, 1938 and 1950, to keep its provisions abreast of advancing technology.

A fifth revision, dated December, 1956, has just made its appearance, and a new feature of the standard is the inclusion of two proportional test pieces. These may be of circular, square,

A turbine rotor being investigated for internal faults with an ultrasonic detector. The rotor is mounted in a lathe with the probe of the detector carried in the tool rest.

rectangular or hexagonal cross-section, with gauge lengths equal to 4 times and 5·65 times the square root of the cross-sectional area of the parallel portion of the specimen. They are two of the test pieces which have been recommended by the technical committee on steel of the International Organisation for Standardisation (I.S.O.).

The general clause relating to proof stress has been revised and clauses for permanent-set stress and proving tests have been introduced. It is directed that the permanent-set stress shall be determined by applying a sequence of increasing loads to the test piece; each load being applied for approximately ten seconds and then removed. After the removal of each load the permanent extension shall be determined and the test stopped after the test piece has acquired a permanent extension in excess of that corresponding to the specified percentage strain. In specifying or describing a permanent-set stress, the percentage permanent strain should be quoted. An example of this would be a 0·2 per cent. permanent-set stress.

A third change is that the term "tensile strength," which is defined as the maximum load divided by the original cross-sectional area of the test piece, has been adopted in place of "ultimate tensile stress." The abbreviation T.S. therefore replaces U.T.S.

An appendix gives a list of the symbols utilised in the Standard and the corresponding symbols adopted by the International Organisation for Standardisation.

Copies of the Standard are obtainable from the Sales Branch of the British Standards Institution, 2 Park-street, London, W.1, price 4*s*. post free.

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CUTTING BILLETS FOR FORGING

Fully-automatic operation is possible on the cold billet shear introduced by Lamberton and Company, Limited, Coatbridge, Scotland. Alternatively, it can be set for single-stroking under the control of a pedal. The shear is particularly applicable to the preparation of billets for hot forging, where short lengths with reasonably clean-cut ends are essential.

A heavy fabricated steel frame is the basis of the shear, with cartridge-type bearings for the eccentric shaft. Generous guiding surfaces are provided for the blade apron, with prolongations extending below blade level to resist the blade-separating tendency induced by the shearing load. The shearing stroke can be varied to suit the size of the material cut. The drive is from an electric motor through V-belts to the grooved rim of the flywheel, and thence by machine-cut gears and an air-operated clutch to the eccentric shaft. The flywheel drives its hub through friction discs, which allow a safety slip in the event of overload. Billet entry to the shear is over a freely-rotating spring-loaded roller attached to the machine frame. When a roller feed table is supplied the entry roller is driven from the last roller on the table.

A special feature of this shear is the Lamberton patented multi-wedge hold-down. This consists of a series of wedges acting in a horizontal plane which give a vertical movement to the hold-down ram. The wedges are moved by a double-acting compressed-air cylinder, and the hold-down ram is balanced by a further air cylinder, which ensures instant release on completion of a cut. The wedge gear is totally enclosed, and so protected from dirt and scale.

The hold-down comes into operation automatically as soon as the end of the billet makes contact with an adjustable, pneumatically controlled measuring stop. This is the beginning of the automatic cycle, which continues as the roller feed table driving motor stops; the measuring stop withdraws from contact with the billet, and the clutch engages to make a single shearing stroke. When the cut piece has fallen clear the measuring stop re-sets itself, the shear blade returns to the fully-open position, and the hold-down is released to allow the billet to be fed forward again. The cycle then repeats, and this will continue as long as a master switch remains set to "auto." Setting the switch to "pedal" enables the shear to be controlled by an operator using a pedal. The shear then stops at the end of a single cutting stroke, the hold-down is released, and the next stroke only takes place when the pedal is depressed.

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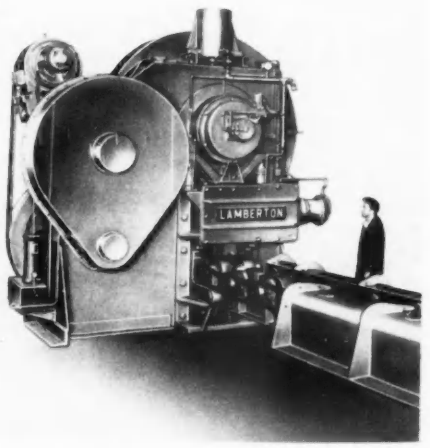
CARBON DIOXIDE SHIELD IN ARC WELDING

The Fusarc/CO_2 process is the name given to a method of automatic arc welding recently introduced by Quasi-Arc Limited, Bilston, Staffordshire, in which a continuous covered electrode is used in conjunction with a carbon dioxide gas shield. The combination of flux and gas shielding, it is pointed out, allows considerably higher welding speeds to be achieved than is the case with flux alone and the deposited weld metal is very satisfactory from a metallurgical standpoint.

The makers emphasise that the outstanding feature of the process is the ability to make horizontal-vertical fillet welds of high quality at high speeds. Another feature of the new



Fully-automatic or pedal-controlled operation is available on the Lamberton cold billet shear by means of a switch setting.

method is the wide range of depth of penetration obtainable, and therefore the exact composition of the weld metal in any given joint will be influenced by the composition of the parent plate. A typical analysis of undiluted weld metal gives the following percentage composition: carbon 0·06, manganese 0·80, silicon 0·25, sulphur 0·03, phosphorus 0·03, and nitrogen 0·01. It is added that the use of the CO_2 gas shield does not give rise to any carbon pick-up in the weld metal. The process, moreover, does not produce acrid fumes and in the larger shops local fume-extraction equipment is not necessary. In confined spaces, however, fume extraction measures must be adopted but the normal regulation provisions for such work are quite adequate.

The process may also be used for single-pass and multi-pass butt welding and, as a high degree of control can be exercised over the penetration, square-edge butt welds are possible over a range of plate thicknesses from $\frac{1}{8}$ in. to $\frac{3}{4}$ in.

The rate of flow of carbon shielding gas is about 25 to 30 cub. ft. per hour and need not be increased above these figures even when fume-extraction equipment is used. Welding in the open under moderately windy conditions will require somewhat greater gas flows and full protection of the weld will then be achieved. Under very windy conditions local wind-breaks in conjunction with higher gas flows allow full gas shielding of the arc to be obtained.

The process operates at maximum electrode-feed speeds of up to 100 in. per minute and at maximum traverse speeds of up to 100 in. per minute. Automatic arc-welding heads are designed to operate at these speeds with welding currents of up to 1,400 amperes. Self-propelled machines are available for general applications and stationary heads for shop fixtures.

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EPOXIDE-RESIN VACUUM FORMING MOULDS

The vacuum forming of thermoplastic resin sheets is a simple operation performed with comparatively low-cost equipment. When using a female mould the thermoplastic sheet is placed over the mould and is clamped down in such a manner as to form an air-tight seal over the mould cavity. A suitable low-temperature heater is then run over the sheet and removed when the latter has been rendered soft and pliable. The air between the sheet and the mould is quickly evacuated and this causes the atmospheric pressure to shape the sheet on to the mould contours. When cool enough, i.e., after a few seconds have elapsed, the vacuum-formed component is removed. The proceeding when employing a male mould is very similar. The thermoplastic sheet is first clamped in a frame arranged over the mould, and, when rendered soft and pliable by heating, the sheet is " draped " over the mould and immediately clamped in order to seal the edge of the sheet. The air between the mould and the sheet is then quickly evacuated and final moulding completed as before.

Depending on the number of finished articles required, moulds made of certain kinds of wood, plaster, and various aluminium casting alloys have been advocated. Plastics, however, are increasingly coming to the fore for this application, and in this connection Bakelite Limited, 12-18 Grosvenor-gardens, London, S.W.1, inform us that they have now available for issue detailed techniques for the preparation of epoxide-resin moulds which are speedily produced, and appreciably cheaper than metal moulds. Another advantage is that epoxide-resin moulds present a highly-glossy surface to the heat-softened and often highly-polished thermoplastic sheet. Moreover, the method of preparing the moulds can be readily varied to suit individual requirements and a further advantage of the process lies in the ease with which a mould can be cast directly from a pattern or dummy, or, in some cases, from the article which it is intended to reproduce.

PROTECTIVE MULTIPLE EARTHING

BRITISH AND OVERSEAS PRACTICES

Although direct earthing and earth leakage protection are both common practice in factory electrical installations in this country at the present time, there are difficulties in the way of their use where domestic consumers and farms are supplied by an overhead line, since a cable sheath is not available as a metallic return. In such cases an earthing conductor can be run on the overhead line, but this is expensive and a cheaper alternative is protective multiple earthing.

In this system the neutral conductor is earthed at a number of points and the apparatus frames are solidly connected to it. A disadvantage compared with direct earthing is that if the neutral conductor is fractured all installations beyond that point will be raised in potential; and, if the earthing conditions are not good enough to keep this potential down to a safe level, there will be a wide zone of risk. Some of the results which have been obtained with it both in this country and elsewhere were compared by Mr. S. J. Emerson in a paper read recently before the Association of Supervising Electrical Engineers.

In Germany it was generally conceded that neutral earthing was the simplest and most satisfactory method of protection. Its employment was, however, subject to three main requirements, the first of which was that the cross-sectional area of the phase and neutral conductors should be such that in the event of a short-circuit between them at least 2·5 times the rated current of the nearest fuse would be able to flow, this being the value of the minimum fusing current. Secondly, the system must be designed so that where a phase conductor made accidental contact with earth and the earth resistance at that point was low the rise of voltage in the neutral must not exceed a certain value. The third requirement was that the neutral conductor must be designed and constructed so that it would not be likely to break. This was hardly practicable on overhead lines.

The results of a questionnaire sent to 86 supply authorities in Germany showed that 59 per cent. of the 3,790,000 consumers supplied on the four-wire system used neutral earthing, 28 per cent. direct earthing and 13 per cent. earth-leakage circuit-breakers. On one large system, however, where 840,000 consumers were supplied on the four-wire system only 5 per cent. used neutral earthing as against 55 per cent. who employed direct earthing and 40 per cent. earth-leakage circuit-breakers. This lack of unanimity in a country where perhaps the greatest experience of multiple earthing was available was interesting, but it was worth noting that it was considered earth-leakage circuit-breakers should only be installed in dry situations and that they were thought to be an expensive form of protection.

In Eire neutral earthing, direct earthing and earth leakage circuit-breakers of both the voltage operated and differential current types were all used, the choice depending on the presence or absence of a town's water supply, the nature of the ground and certain features of the local electrical distribution system. Where neutral earthing was permitted a connection was made between the consumer's main earthing terminal and the neutral conductor of the supply through a " neutralising bridge." A connection was also made to the consumer's earth electrode.

Besides Germany and the United States (where multiple earthing was dealt with on practical lines in the National Electric Code) multiple earthing of the neutral was extensively used in Canada, Australia, New Zealand and Switzerland. Generally speaking, the experience in all these countries was satisfactory, especially in Australia, where the earthing conditions tended to favour its adoption.

In this country the conditions laid down by the Ministry of Fuel and Power for the employment of protective multiple earthing required that the neutral point of the supply transformer be earthed to an electrode the resistance of which was low enough to permit the operation of the fuses on the high voltage side in the event of a fault occurring between the high and low voltage windings. Earth electrodes must also be provided at or near the end of each distributor or branch and also at points along the distributor spaced sufficiently evenly to ensure that the resistance to earth of the neutral conductor did not exceed 10 ohms. A number of experimental installations had been set up within this framework and were giving good results, but the number of consumers affected was small, compared with those in Germany.

Summarising British practice, which in his opinion appeared to be developing on the right lines, Mr. Emerson pointed out that direct earthing was used in all residential areas and in those with small factories on the medium voltage mains. It was also employed in larger factories with their own supply transformer, alternatives being a metallic earth return back to the transformer neutral or earth leakage protection of one type or another. In rural areas a metallic return could be used, particularly where part of the network was underground in cable, and the sheath could be employed as an extended electrode. Other methods were earth-leakage circuit-breakers and protective multiple earthing, the latter being applied where small supplies were being given to about half a dozen farms or rural consumers from a single-pole transformer. One or other of these methods could be selected by the supply authority according to circumstances. This position was thus satisfactory and no general change over to protective multiple earthing should be made at the present time.

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FLUORESCENT LIGHTING IN COAL-MINES

Brightness Without Danger

For the first time, the United States Bureau of Mines has approved two commercially-made lighting systems for use in gassy or dusty coal-mines. The fixtures of the two approved systems each take advantage of the intrinsic safety of fluorescent tubes when used in an instant-start circuit. They are designed to be suspended vertically and to be spaced at about 18 ft. intervals. Each fixture is about 18 in. high and 6 in. in diameter, and has two 14 watt fluorescent lamps mounted side by side in a transparent plastic tube. By way of testing the performance of the lights, they were broken in an atmosphere containing an explosive concentration of both gas and coal dust. No explosion occurred.

The importance of the development is emphasised in the report by Mr. M. J. Ankeny, the Bureau Director. " These approvals, granted after rigorous testing, fulfil a need that has existed since mining of coal began and may bring about one of the greatest advances in mine safety in recent times. Lack of adequate illumination in coal-mine working areas has contributed to many accidents and hampered production, and the hazard has increased with spreading mechanisation. Until now, however, the fire and explosion risk created by lights drawing current from mine electrical circuits has outweighed the hazards caused by poor visibility. Steady overall lighting of coal-mine working places should mean fewer accidents and greater productivity in the most hazardous underground areas. Now that one manufacturer has successfully met the tests, I hope additional safe lighting systems will be developed and that widespread acceptance by coal producers will result."

SILENCING A TURBOJET ENGINE HOUSE

ACOUSTIC DESIGN OF A HIGH-SPEED WIND TUNNEL

By A. J. King, M.SC.TECH., D.SC., M.I.E.E., F.INST.P.*

The following article describes the acoustical design of a new high-speed wind tunnel for aerodynamic research at the Radlett works of Handley Page, Limited.

In planning the wind tunnel installation it was emphasised that, as far as possible, there should be no cause for complaint concerning an increase of noise in the surrounding district. It was, therefore, essential to know, firstly, the level of noise existing and regarded as tolerable at the important points in the district and, secondly, the noise generated by the tunnel power units, three Rolls-Royce Nene turbojets.

Inspection of the site showed that the nearest residential buildings would lie about ¼ to ½ mile away in all directions, so there was no possibility of merely confining the sound to a directional beam. Experience on similar noise abatement problems has indicated that if the noise outside a dwelling house does not exceed 40 phons, there is no likelihood of complaint. However, at the proposed site, much louder noises than this were already occurring intermittently due to passing trains on a nearby line and to aeroplanes taking off from the runway of Radlett Aerodrome and flying over at low altitudes; thus, the noise level of 40 phons quoted above was regarded as unnecessarily exacting and could reasonably be exceeded by 10 or 20 phons.

In order to obtain the necessary information on the noise of the driving engines, Rolls-Royce Limited arranged for a similar engine to be run in a test tunnel at their Hucknall works, and the noise was measured and analysed by the Research Department of the Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester. The exhaust noise was found to be greatest in a direction at approximately 45 deg. to the axis of the tunnel, and at 30 yards from the mouth in this direction the sound level was 112 db. With three engines running there should be an increase of 5 db, and at 440 yards there should be an attenuation of 23 db, giving a net level of 94 db. To reduce this to 40 db, which is roughly the sound level corresponding to 50 phons for this type of noise, called for an overall attenuation of 54 db.

At 10 yards from the inlet on the axis of the tunnel the sound level with one engine was 106 db. The distribution of sound energy with frequency was similar to that at 30 yards from the exhaust except that the low frequencies were 10 db less and there was a peak of 10 db at 6,200 cycles per second due to the compressor. At 440 yards the attenuation with distance should be 33 db so, with three engines running, an overall attenuation of 38 db was required. It was therefore necessary to provide silencers at the inlet and exhaust giving overall attenuations to this wide spectrum noise of 38 and 54 db, respectively. In addition, it was essential to provide enclosures giving corresponding attenuations for the engines and silencers in order to deal consistently with all the paths by which the noise could escape, since inadequate treatment of any one path could nullify the additional treatment of all the other paths.

WIDE FREQUENCY SPECTRUM

Considering firstly the silencers, published nformation[1] on the attenuation that can be obtained by ducts with sound-absorbent linings or subdivided by "splitters" required some extrapolation at low frequencies. In dealing with a wide spectrum noise such as that of a jet engine, difficulties arise mainly in obtaining sufficient attenuation at the high and low frequency ends of the spectrum. At low frequencies it is necessary to use either porous linings of the order of one-tenth of a wavelength thick or resonant absorbers in order to achieve a low acoustic impedance and so a useful attenuation. The latter method has the disadvantage of being effective over only narrow bands of frequency.

At high frequencies it is necessary to use either narrow air passages not more than two wavelengths wide or a large number of changes in direction to ensure enough reflections to give good absorption and attenuation. The latter method is apt to be selective in the frequencies at which it provides good attenuation and may cause more back pressure than straight-through passages. The analysis at the exhaust showed a fairly uniform distribution of sound energy over the frequency range 50 to 3,000 cycles per second, falling off down to 25 cycles and up to 8,000 cycles. However, after taking into account the variation in sensitivity of the ear with frequency shown in the equal-loudness contours of Fig. 1, the additional attenuation required is shown in Table I.

TWO-STAGE SPLITTERS

Considering a straight-through splitter-type silencer in order to minimise back pressure, the low frequencies call for sound-absorbing splitters 1 or 2 ft. thick, whereas the high frequencies call for air passages not more than 3 in. wide. Such an arrangement with a fractional effective cross-section* of only ½ would be quite uneconomic[2], so it was decided to design a two-stage silencer, each stage having a 50 per cent. effective cross-section. The low-frequency section covering roughly 50 to 1,000 cycles consisted of a 10 ft. length of 16 in. thick splitters with 16 in. air spaces. The high-frequency section overlapped somewhat, covering roughly 500 to 8,000 cycles by means of a 5 ft. length of 3 in. splitters with 3 in. air spaces. These two sections operated in cascade, the high frequency section to the outside so as to attenuate any noise associated with turbulence in the space between them. In view of the gas velocity, the leading edges of the splitters are rounded and the trailing edges have tails. The arrangement is shown in Fig. 3.

Following the same general method, the additional attenuation required from the engine air inlet silencer is given in Table 2. The absorbent splitters for the air inlet can be seen in Fig. 2.

Owing to the reduced attenuation required at low frequencies, a 5 ft. length of 16 in. splitters with 16 in. air spaces was considered adequate for these frequencies, followed by a 5 ft. length of 3 in. splitters as before for the higher frequencies. Again the high frequency splitters are further from the engine than the low frequency.

Since there was some uncertainty as to the amount of noise which would leak by way of the recirculation cross-duct (the purpose of which is to divert some of the hot exhaust gases to the

* The ratio of air-passage area to total duct cross-sectional area.

TABLE I ADDITIONAL ATTENUATION REQUIRED AT EXHAUST

Frequency, cycles per sec.	50	100	200	500	1,000	2,000	4,000	6,000	8,000
Attenuation, db.	6	28	55	56	53	57	52	31	24

TABLE II ADDITIONAL ATTENUATION REQUIRED AT ENGINE AIR INLET

Frequency, cycles per sec.	100	200	500	1,000	2,000	4,000	6,200	8,000
Attenuation, db.	8	30	45	49	50	44	37	11

Fig. 1 (right) Equal loudness contours determined under free field conditions.

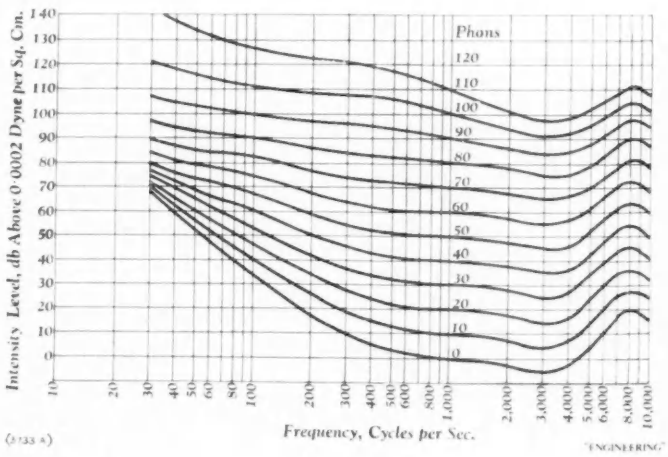

Fig. 2 (below) The engine air-inlet end of the tunnel.

* Research Department, Metropolitan-Vickers Electrical Company Limited.

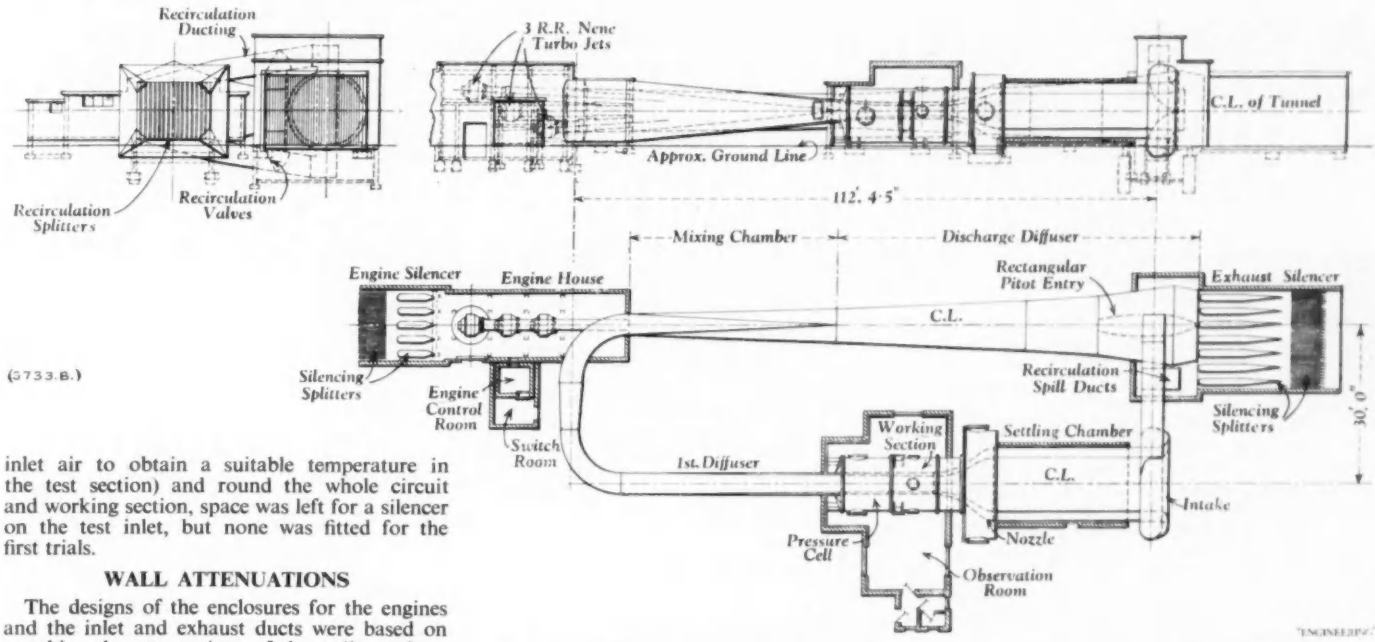

Fig. 3 Plan of tunnel, which is of induced-flow type and powered by three Rolls-Royce Nenes.

inlet air to obtain a suitable temperature in the test section) and round the whole circuit and working section, space was left for a silencer on the test inlet, but none was fitted for the first trials.

WALL ATTENUATIONS

The designs of the enclosures for the engines and the inlet and exhaust ducts were based on matching the attenuations of the walls to those of the silencers except where structural considerations demanded greater wall thicknesses than would have been adequate acoustically.

The sound attenuation given by enclosures such as single brick walls is mainly dependent on the mass of the wall and on the frequency. The variation in attenuation with frequency for enclosures of typical mass per sq. ft. is shown in Fig. 4. It is seen by inspection that an enclosure of approximately 10 lb. per sq. ft. would satisfy the requirements of Tables I and II at 1,000 cycles and above, but that 10 times this mass would be necessary to provide the 55 db attenuation required at 200 cycles in Table I. Steel plate ¼ in. thick has a mass of approximately 10 lb. per sq. ft., so it was decided to use this for the exhaust duct—which in addition has to withstand an operating temperature of up to 200 deg. C.—and to hold in reserve the possibility of an outer shell loaded with earth. At low frequencies the stiffness of enclosures becomes important, so that curved plates are preferable to flat ones.

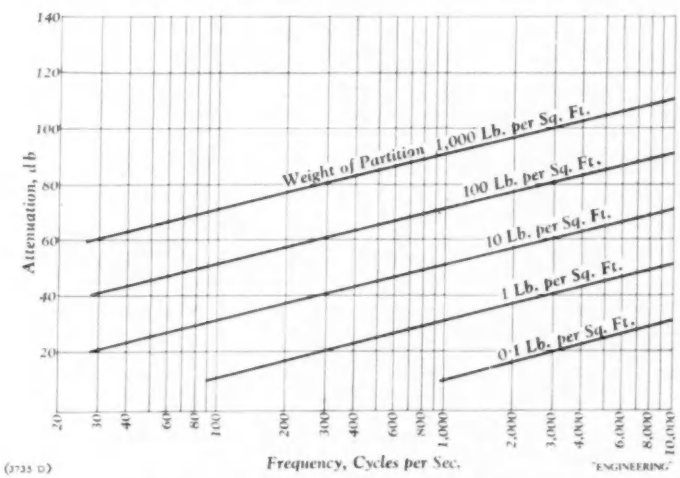
Attenuation, db
Weight of Partition 1,000 Lb. per Sq. Ft.
100 Lb. per Sq. Ft.
10 Lb. per Sq. Ft.
1 Lb. per Sq. Ft.
0·1 Lb. per Sq. Ft.
Frequency, Cycles per Sec.
(3733 D)
"ENGINEERING"

Fig. 4 Attenuation of sound by partitions.

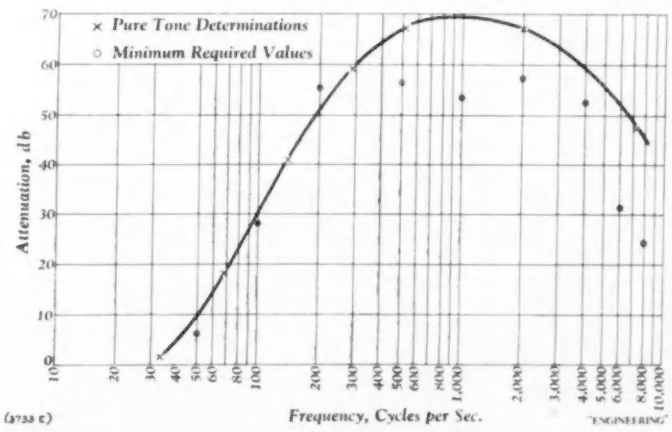

Fig. 5 Attenuation produced by exhaust silencer.

As regards the engine house, building requirements call for a minimum of 9 in. brickwork, which has a mass of 90 lb. per sq. ft., and so should be adequate. In view of the difficulty of providing effective resilient mountings for the engines and so of preventing powerful vibrations from reaching the building, the possibility of providing an outer enclosure separated at the foundations and by air spaces from the building was kept in reserve.

TESTING THE INSTALLATION

The acoustical performance of the installation was assessed by two sets of tests. For the first the author is indebted to Burgess Products Limited, who were responsible for the manufacture of the absorbent splitters in the silencers and who took some measurements with a sound level meter in the vicinity of the test house with two Nene engines running. The sound levels were 98 db at the engine air intake, 120 db near the main engine duct, 110 db. near the mouth of the exhaust and up to 118 db. near the test air intake. At 700 yd. the noise had fallen to the background level of approximately 70 db. While this is not as low as was originally envisaged it was considered to be quite satisfactory. The double enclosures and fitting of a silencer to the test air intake were therefore not considered to be necessary.

The second set of tests was carried out by the Research Department of Metropolitan-Vickers Electrical Company Limited to determine the attenuation of the exhaust silencer. Pure tones were generated by an oscillator and a loudspeaker inside the main duct and were measured just before and just outside the silencer. The variation in attenuation with frequency is shown in Fig. 5. This confirms the attenuation of nearly 3 db. per ft. at 100 cycles which had been estimated for the low frequency section by extrapolation of previous data[1].

Since the attenuation provided by the silencers agrees well with the design performance, it is probable that the fact that the noise level at a distance is somewhat greater than the target value is due to leakage of sound by other paths, e.g., by the reheat circuit and test air inlet and through the walls of the ducts. However, since the tunnel operated for several months unobserved, it was considered unnecessary to proceed with any of the reserve measures.

The writer acknowledges gratefully the co-operation and assistance he has received from Mr. A. E. Cresswell, architect, and Mr. F. R. C. Hounsfield, test engineer, Handley Page, Limited, from his colleagues in the Research Department of the Metropolitan-Vickers Electrical Company, Limited, and from the other firms and individuals connected with this undertaking. In particular he is indebted to Rolls-Royce Limited, for running engines on test at Hucknall and permitting noise measurements to be made on them, and to Burgess Products Company, Limited, for the figures quoted from their noise survey carried out by Mr. E. G. Ewing, round the test house. His grateful thanks are also tendered to Sir Frederick Handley Page, C.B.E, chairman and managing director, Handley Page Limited, and to Mr. B. G. Churcher, M.Sc., manager, Research Department and Dr. Willis Jackson, F.R.S., director of research and education, Metropolitan-Vickers Electrical Company Limited, for permission to publish this paper.

BIBLIOGRAPHY

[1] A. J. King *et. al.*, "Attenuation of Sound in Lined Air Ducts," ENGINEERING, vol. 165, pages 97 and 145 (1948).

[2] A. J. King, Discussion on "Ground-to-Ground Noise." *Journal of the Royal Aeronautical Society*, April, 1954, page 251.

TURBO-GENERATOR EFFICIENCIES

A STANDARD OF COMPARISON

*By E. T. G. Emery**

It is often necessary to estimate the efficiency obtainable from a turbo-generator of a given size, type and speed and operating with given terminal conditions. For example, an estimate may be required for a machine not yet designed except in broad outline, or for assessing whether a guaranteed efficiency is high or low in comparison with average machines. For machines in operation, a standard efficiency is also useful in interpreting test results or for comparing machines with different characteristics.

Comparisons between machines operating under different terminal conditions are sometimes made on the basis of the ideal cycle efficiency, formulae for which were published by J. F. Field in 1938. The formulae, which are given in the appendix to this article, however, only take into account the terminal conditions and, therefore, make no allowance for design features, such as the number of feed water heaters, size and speed. Various attempts have been made† to define a criterion of turbo-generator efficiency taking into account the fact that practical machines have a finite number of feed water heaters as distinct from the infinite number assumed by the ideal efficiency formulae. These attempts, however, have dealt only with the regenerative cycle and have not taken into account the size and speed of the machine.

Neither the ideal cycle formulae nor these criteria provide a completely satisfactory basis for assessing turbo-generator performance. The ideal cycle formulae no doubt serve a useful purpose by establishing the absolute maximum of efficiency of the regenerative and reheat cycles, but the other criteria, which have been based on machines with certain "ideal" and "practical" features, yield efficiency figures which fall between the two extremes, giving neither the maximum nor the practical value but a figure between the two. What is wanted is a simple method of estimating the actual efficiency obtainable by an average machine. This is provided by the formulae given below where it is shown that the "expected efficiency" may be expressed in the form:

$$E = K\,I\,m_1\,m_2 \quad . \quad . \quad (1)$$

where K is a factor depending upon the speed and capacity of the machine, I is the ideal cycle efficiency, m_1 is a factor depending upon the number of feed water heating stages and m_2 is a factor depending on the entropy of the steam at the turbine stop valve in the case of the regenerative cycle or on the temperature and entropy of the reheated steam in the case of the reheat cycle. The term "expected efficiency" is derived from mathematical nomenclature and was chosen because such terms as "ideal efficiency," "standard efficiency" and "basic efficiency" had already been used for other quantities.

Information on the variations in efficiency of actual machines with variations in terminal conditions is, however, available in the form of curves published by K. Baumann‡ for the regenerative cycle and J. C. London§ for the reheat cycle. These curves, which in each case were based on actual design calculations, deal only with efficiency variations relative to certain defined standard terminal conditions; if however a reasonable estimate can be made of the actual efficiency obtainable with a given size, type and speed of machine for any given terminal conditions, they provide a valid basis for the comparison of practical machines. The curves are not reproduced here as it has been found possible to summarise the information in a form which is more convenient for general use.

A difficulty which arises in the use of the original curves is that, on account of the large amount of detailed calculation involved, they have been plotted only for certain widely spaced values of terminal conditions, so that it becomes necessary to interpolate between them. The ideal cycle formulae are easy to evaluate for a variety of different terminal conditions, and it appeared that useful results might be obtained if relative efficiencies similar to those published for practical machines were calculated by the ideal cycle formulae. The ideal and the practical relative efficiencies could then be compared, in order to provide data for converting relative efficiencies, calculated from the ideal cycle formulae, to practical values as given by the curves based on design calculations.

When this was carried out for the regenerative cycle, it was found that the ratio of practical relative efficiency to ideal relative efficiency gave points falling on a single straight line, for all pressures and temperatures and for vacua varying from 28 in. to 29 in., when plotted against the steam entropy at the stop valve. It is not known why this occurs, but the result is extremely useful in facilitating the development of a method of estimating turbo-generator efficiency in a convenient form for general use. The equation of the straight line was found to be:

$$m_2 = 0{\cdot}31 + 0{\cdot}423\,\Phi_0 \quad . \quad . \quad (2)$$

where Φ_0 is the entropy of steam at the stop valve.

The practical efficiencies of machines operating on the regenerative cycle were calculated on the basis of five stages of feed water heating; and in order to cater for other numbers of stages it is necessary to introduce a further correction (m_1) which has been estimated for various data on the improvement in efficiency of practical machines corresponding to the number of feed water heaters. The improvement is not entirely independent of stop valve conditions, but it was found that for the ranges of values occurring in practice, the factor could be regarded as having the constant values given in Table I.

In order to establish the actual efficiencies obtainable in practice, it is necessary to introduce a further factor K relating the efficiency to other characteristics of the machine. The additional information required has been obtained from a statistical analysis of the particulars of a large number of machines installed in British power stations. The machines were mainly of less than 60 MW capacity and the formula obtained for 3,000 r.p.m. machines up to 60 MW continuous maximum rating was:

$$100\,K = 72{\cdot}27 + 0{\cdot}2148\,C - 0{\cdot}001594\,C^2 \quad (3)$$

where C is the maximum continuous rating in mega watts.

For capacities greater than 60 MW, K has been established on the basis of design data and may be represented by the formula:

$$100\,K = 77{\cdot}62 + 0{\cdot}0356\,C - 0{\cdot}0001\,C^2 \quad (4)$$

TABLE I.—VALUES OF m_1 FOR VARIOUS NUMBERS OF HEATERS

Number of stages of feed water heating	1	2	3	4	5	6
Value of m_1	0·965	0·985	0·992	0·996	1·0	1·003

TABLE II.—VALUES OF K FOR 3,000 R.P.M. TURBO-GENERATORS

Continuous max. rating, MW	30	45	50	60	100	120	200
Value of K	0·773	0·787	0·790	0·794	0·802	0·805	0·808

TABLE III.—VALUES OF m_2 FOR ONE FEED WATER HEATER BEFORE THE REHEATER

Entropy of reheated steam	A. Reheat to stop valve temperature				B. Reheat to 50 deg. F. less than stop valve temperature			
	Temperature of reheated steam, deg. F.				Temperature of reheated steam, deg. F.			
	850	900	950	1,000	900	950	1,000	1,050
1·68	0·990	0·986	0·982	0·978	0·993	0·990	0·986	0·984
1·70	0·999	0·995	0·991	0·987	1·000	0·996	0·993	0·990
1·72	1·008	1·004	1·000	0·996	1·007	1·003	1·000	0·997
1·74	1·016	1·012	1·008	1·004	1·013	1·010	1·007	1·005
1·76	1·024	1·020	1·016	1·012	1·020	1·016	1·013	1·010
1·78	1·031	1·027	1·023	1·019	1·027	1·023	1·020	1·017
1·80	1·038	1·034	1·030	1·026	1·033	1·030	1·026	1·024
1·82	1·044	1·040	1·036	1·032	1·040	1·036	1·033	1·030
1·84	1·050	1·046	1·042	1·037	1·047	1·043	1·040	1·037

This formula has a maximum value of 0·808 at 178 MW, and until more data is available it is suggested that the figure of K = 0·808 should be used for all machines of capacity greater than that figure. Calculated values of K are given in Table II.

Machines running at 1,500 r.p.m. are on the average slightly less efficient than 3,000 r.p.m. machines of similar size, operating at the same terminal conditions. The difference may be taken into account by subtracting 1·6 from the value of 100K given by formulae (3) and (4).

The information given by J. C. London* indicates that in the case of the reheat cycle, the value of m_2 depends upon the condition of the reheated steam rather than on that of the initial steam, and that the relationship with entropy is not quite linear. The value depends also on the temperature of the reheated steam in relation to the stop valve temperature and upon the number of feed water heaters placed before the reheater. Values may be calculated from the following formulae which apply to the case where one feed-water heater is placed before the reheater.

Reheating to the stop valve temperature:

$$m_2 = -1{\cdot}5608 - 0{\cdot}083\,t_r + 2{\cdot}644\,\Phi_r - 0{\cdot}645\,\Phi_r^2 \quad (5)$$

Reheating to a temperature 50 deg. F. below the stop valve temperature:

$$m_2 = 0{\cdot}5233 - 0{\cdot}2372\,t_r + 0{\cdot}088\,t_r^2 + 0{\cdot}393\,\Phi_r - 0{\cdot}017\,\Phi_r^2 \quad (6)$$

where t_r is the temperature of reheated steam in degrees F. divided by 1,000, and Φ_r is the entropy

* Mr. Emery is with the Central Electricity Authority.

† S. L. Pearce, *Proceedings of the Institution of Mechanical Engineers*, vol. 142, page 305 (1939); H. S. Horsman, *ibid.*, vol. 146, page 5 (1941); R. W. Haywood, *ibid.*, vol. 161, page 157 (1949).

‡ K. Baumann, *Proceedings of the Institution of Mechanical Engineers*, vol. 155, page 125 (1946) and vol. 160, page 61 (1948); and J. K. Finniecombe, *ibid.*, vol. 155, page 134 (1946).

§ J. C. London, *Proceedings of the Institution of Mechanical Engineers*, vol. 1B, page 259 (1952).

* *Loc. cit.*

of the reheated steam. Values of m_2 calculated by these formulae are given in Table III. For two feed water heaters before the reheater, the values of m_2 should be reduced by 0·010 and for three feed water heaters before the reheater, by 0·022 in the case of reheat to stop valve temperature, and by 0·021 in the case of reheat to 50 deg. F. below the stop valve temperature.

In applying the above methods of estimation, the appropriate formula for ideal cycle efficiency should be evaluated with the final feed water temperature and vacuum corresponding to the normal economic rating of the set. Equation (1) will then give an estimate of the efficiency obtainable on an average machine at normal economic rating, for which it can be taken that the heat consumption includes the steam supplied to the air ejectors and the output measured at the generator terminals is reduced by the amount of electricity consumed by externally driven ventilation fans, exciters, hydrogen cooling auxiliaries as well as by extraction and drain pumps.

Thus, while the ideal cycle efficiency expresses the ideal maximum which is unattainable by any practical machine, the expected efficiency given by equation (1) expresses the average value actually obtainable. If the ratio of the actual turbo-generator efficiency to the expected efficiency is calculated for each of a number of individual machines and expressed as a percentage, then since 100 per cent. represents the expected value for an average machine, figures above, as well as below, 100 per cent. will occur for the individual machines. The amount by which the efficiency ratio differs from 100 shows immediately the percentage by which the efficiency of a machine differs from the average for machines of similar size and speed and with similar terminal conditions.

Since for any given terminal conditions and machine characteristics, many variations in details of design are possible, the efficiency obtained in practice will be related to the cost of the machine, and while this remains a major factor affecting the turbo-generator efficiency, there is no point in elaborating the estimation formulae by taking construction into account.

An analysis of the test results of a large number of machines installed in British power stations shows that efficiency ratios are distributed about the mean value of 100 per cent. with a standard deviation of 2 per cent. so that 95 per cent. of all machines have efficiency ratios within the range 100 $\pm$ 4 per cent.

APPENDIX

Formulae for Ideal Cycle Efficiency

Regenerative cycle

$$I = 1 - \frac{T_c\,(\Phi_o - \phi_f)}{H_o - h_f} \quad . \quad . \quad (1)$$

Reheat cycle

$$I = 1 - \frac{T_c\,(\Phi_r - \phi_f)}{H_o - H_1 + H_r - h_f} \quad . \quad (2)$$

Where T_c is the absolute-temperature corresponding to the vacuum; H_o the total heat of steam at the stop valve; Φ_o the entropy of steam at stop valve; H_1 the total heat of the steam corresponding to the initial entropy and the reheat pressure; H_r the total heat of reheated steam; Φ_r the entropy of reheated steam; h_f the total heat of the water at the final heater outlet and ϕ_f the entropy of the water at the final heater outlet.

DE-ICING TENDERS FOR ELECTRIC CONDUCTOR RAILS

One of the operating problems that has to be faced by railway system swhich depend on a third rail for supplying current, is that of the formation of ice on the rail, which will prevent contact between the rail and shoe. In this country, the Southern Region and those London Transport lines which run above ground are particularly affected. Various methods have been tried to prevent the formation of ice, including the running of trains at frequent intervals throughout the night, and the use of a de-icing fluid either sprayed on to the rail by passing trains, or transferred by the shoe from troughs mounted at suitable intervals. The " sleet " locomotives used for some years on the London Transport lines were described in ENGINEERING, vol. 178, page 831, 1954, and these used a spray method.

A further development by London Transport has now been announced, in which these locomotives are replaced by tenders attached to the front and rear of empty service trains. A prototype is shown in the illustration. One reason for the introduction of the new tenders is that the locomotives are rapidly becoming out of date, and would be very costly to modernise. Also, the initial and maintenance costs of the tender are less, as no special crew is required. The tender has been kept to a restricted height to allow the driver of the train a clear view over it, and is made basically from a four-wheel bogie, on which are mounted two tanks containing the de-icing fluid and sets of brushes and crushing rollers similar to those used on the sleet locomotives.

To suit the arrangement of the London Transport lines, three sets of brushes have to be provided, one for the centre rail and one on each side for both positions of the outside rail. Compressed air from the train system is used to lower the side rollers and brushes to make contact with the rail, and they are raised by spring pressure. The sprays are fed by an axle-driven pump from the two 75 gallon tanks mounted on top of the frame. The normal delivery rate is 0·9 gallon of fluid per mile. A lever-operated dog clutch engages the pump as required.

Since the spray is only required on the rail and the position of the outside rail varies, a roller is mounted on each side so as to ride on the rail and, when no rail is present, cut off the supply of fluid. A relief valve in the fluid circuit, which has a return line to the tank, acts as a safety device in the event of the sprays becoming blocked. The tender is fitted with a spring-applied brake which can be released by air pressure; thus in the unlikely event of a break-away, the brake would be applied automatically. When compressed air is not available, a hand-operated release can be used.

London Transport's latest move in the prevention of icing of conductor rails is the introduction of special tenders attached to service trains and fitted with crushing rollers, brushes and fluid sprays.

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RAILWAY MODERNISATION IN FRANCE

An account of work which has recently been completed as part of the electrification programme undertaken by the French railway administration is given in the current issue of the *Bulletin* of the Centre d'Information des Chemins de Fer Europeens, Rome. The 25 kV, 50 cycle alternating-current system on the Valenciennes-Thionville line has been extended in one direction towards Lille and in the other towards Luxembourg, Béning, Metz and Strasbourg. The lines from Dijon to Dôle and from Culoz to Geneva have been electrified on the 1,500 volt direct-current system, thus completing the conversion from steam to electric traction between Paris and Lyons and Geneva. To facilitate running, the section in Switzerland between Bellegarde and Geneva is operated by French locomotives as well as by Swiss railcars for local traffic. The section between Pontarlier and Les Verrières is now being operated by locomotives of the Swiss Railways on the 16⅔ cycle alternating-current system.

At the end of 1956 the French railway mileage totalled nearly 25,000, of which 3,230 miles, or 13 per cent., were operated electrically. The electrified lines, however, carried about 40 per cent. of the traffic.

A further 680 miles of line are in course of electrification. Of these, 460 miles will be converted on the 25 kV, 50 cycles system, including those between Paris and Lille, from Strasbourg to Basle, from Dôle to Vallorbe and from Frasne to Pontarlier. These should be completed by September 1958. The lines from Lyons to Nîmes (174 miles) and Lyons to Saint Etienne (37 miles) are to be changed to the 1,500 volt direct-current system and this work should be completed by the end of 1958.

COAL SAVED

As a result of electrification and the increasing use of Diesel traction, the French railway administration saved 7 million tons of coal during 1956, and it is estimated that this saving will have increased to 10 million tons in 1961.

A further development on the French Railways is the trial of a prototype Diesel-electric locomotive which has been designed for hauling trains of medium tonnage on lines where the track construction is relatively light. To obtain the required weight reduction it was necessary to use a high-speed supercharged Diesel engine, but as there were no single units of the required power available, two with outputs of 900 h.p. at 1,500 r.p.m. have been employed.

Each of these engines drives a generator which supplies six traction motors, the latter being mounted on the axles of two bogies. The weight per axle does not exceed 17·4 tons in spite of the fact that the equipment includes a boiler for supplying heat to passenger trains. The maximum speed of these locomotives is about 81 m.p.h., and 15 are at present under construction for use on the lines between Nantes, Tours and Bordeaux.

Book Reviews

LIGHT IN THE EAST

Science and Civilisation in China. Vol. II: History of Scientific Thought. By JOSEPH NEEDHAM. *Cambridge University Press, 200 Euston-road, London, N.W.1.* (80*s.*)

This is the second volume of Dr. Needham's seven-volume study of Chinese scientific culture from its pre-historic origins to its assimilation into world science in the Seventeenth Century. Three main lines of approach emerge from the volumes which have so far appeared. These are: to cover the indigenous achievement of Chinese science; to relate this achievement to its background; and to examine the development of Chinese science in the light of science in the nearer East and Europe, and to consider the relations between them. The first, and more conventional, of these approaches is chiefly the concern of the four succeeding volumes: volume IV, for example, will cover physics, engineering and technology. Volume I, which was reviewed in our issue of September 30, 1955, was largely taken up with establishing the second approach. Volume II contains sections on geography, history and language, as well as a long section on bibliography and a study of means of communication with the West.

The present volume examines the forces affecting scientific thought. These divide themselves roughly into the attitudes to science of the various Schools, and the conventions associated with scientific method. Each of the Schools is described and emphasis is placed on its concept of nature. Thus Confucianism was conservative and anthropocentric; in politics it was the main-stay of feudal society, and its religion was based on a literary tradition of moral aphorisms going back to Confucius himself. Science was only encouraged where it was relevant to society; the Confucians were not interested in nature as such. In opposition to them were the Taoists. Their first moral law was non-resistence to the Way of Nature; politically, they were anti-feudal, looking back in a Rousseauesque manner to a harmonious primitive society. They believed that everything in nature is significant and connected, but their scientific enthusiasm was hampered by their distrust of reason and logic.

These summaries indicate Dr. Needham's approach. He admires Taoism for its intuition of organic nature (and society) and shows how it is related to scientific discovery. The point is underlined by the Neo-Confucianism of the Eleventh Century, a School which assimilated much of Taoism and was accompanied by the greatest flowering of Chinese science. Negatively, it is further emphasised in the discussion of Buddhism. Dr. Needham can hardly restrain his contempt for this ascetic religion, imported from India, which preaches that the world is illusion and that salvation lies in introspective meditation in search of reality. Mystics and metaphysicians may find this treatment inadequate, but Dr. Needham is a scientist, and they must bear in mind the title of his book.

There are three main conventions of Chinese thought: the Book of Changes (a collection of ancient texts which commanded uncritical acceptance), the Five Elements, and the poles of Yin and Yang. The last two have interesting parallels in pre-Socratic mythology. This brings us to the third of Dr. Needham's approaches. The book is permeated by parallels with, and references to, Greek and European culture, which not only give it significance in terms of familiar western knowledge, but also illuminate certain basic problems of the philosophy of science. In his fascinating final section, for example, Dr. Needham studies the use of the concept of Law in the legal and scientific fields. In the process, he "clarifies his concepts" with summaries of Roman Law and Aristotle on Justice, and gives a five-page account of the shift of emphasis in Europe in the Seventeenth Century, from a rational God to a Universe of Laws. In China, this situation never arose. The comparative absence of a world-view of divine dogma meant that justice was more liberal but science more unsystematic than in Europe. If the dominant Chinese attitude to law was free from the oppressive dogmatism of much of European legal history, Chinese science appears to have been crippled by the absence of a stage of scientific dogmaticism like that of the Newtonian Universe. In short, Dr. Needham's organic approach to scientific history leads him to the paradoxical conclusion that Chinese thought was too advanced: its greatest achievement was an early insight into an organic concept of the universe that anticipated Whitehead. He discusses at length his own view that Whitehead is at the head of a tradition which derives from Tao through the Chinese studies of Leibniz.

Dr. Needham's style is plain and practical, adorned only with familiar idioms. The breadth of his work is exhilarating, and its scholarship, to judge by the seventy-page bibliography and the mass of annotations (which include the Chinese characters of all names and key-words), is classic. Lay readers will be grateful for the incisive clarity with which he approaches his subject, and also the ease with which his more controversial flights may be recognised. This book is a liberal education.

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DESIGNING CASTINGS FOR HIGH QUALITY AND LOW COST

A Practical Guide to the Design of Grey Iron Castings for Engineering Purposes. *The Council of Ironfoundry Associations, 14 Pall Mall, London, S.W.1.* (12*s.* 6*d.*)

There are several parties to the production and use of iron castings, and it is not always easy for any one of them to see how his actions may influence, for good or bad, the work of the others. This applies particularly to the designer, with whom the idea of a casting originates. He, naturally, will be concerned especially with the physical suitability of a casting for the work it has to do, and he will, or ought to, be interested also in the question of cost. But these primary considerations may obscure the fact that something has been forgotten which will cause difficulty when the design gets to the pattern shop, the pattern to the foundry, or the casting to the machine shop. What is worse, a fault may be discovered only after the casting has been put to use. Similarly, features which would be conducive to lower costs can easily be overlooked.

These facts are the basis of the present guide to casting design, first produced in France for the Commission Technique de la Métallurgie des Fontes du Centre Technique des Industries de la Fonderie, and now made available in an English translation by the Council of Ironfoundry Associations. Written primarily from the point of view of the ironfounder, the guide shows that the rules for correct design are based on three considerations: the properties of the material, the intended use of the casting, and simplification of manufacture. Physical and chemical laws govern the first of these factors, and they must be accepted; little else can be done except to modify their effect to some extent. In the other two factors affecting design, there is much scope for the designer to co-operate closely with the patternmaker, foundryman, machinist and user, and it is to this end that the book is written.

The text is set out to show that the series of operations in making, machining and using a casting is an interdependent whole; an important point, since it is of little value to improve the details of one operation at the expense of another, as can easily happen. It may, for example, be found that a design modification which would simplify coremaking would result in an undesirable concentration of metal at one point in the casting. If the series of operations is viewed as a whole, it will be seen that compromise is the answer to problems of this kind.

Using over 100 line drawings as illustrations the text discusses the fundamental properties of cast iron, and considers at length the rules for sound design, starting with elementary principles, such as designing castings so that the stress is taken as far as possible in compression, and then proceeding to less obvious, but equally important, considerations, such as the difficult of feeding heavy sections, and the problem of coring. Several of the illustrations are comparative, showing good and bad designs side by side, and while such a procedure has been criticised sometimes in the past, it would be difficult to find fault with it here, for all too often the "bad" designs are the common ones. The more prominently these can be shown up for what they are, the better.

If it can be argued that some of the rules propounded are elementary, it can also be said that others are not so obvious, except to those accustomed to foundry work, and, in any case, if a book is to do its job properly, it must state the facts in full, regardless of whether or not some of its readers ought to know some of them. This it does, clearly, and without waste of words. If a designer puts all the rules given in this book into practice, his designs cannot help but be better.

ANALYSIS OF LARGE STRAINS

Elasticity, Fracture and Flow, with Engineering and Geological Applications. By J. C. JAEGER. *Methuen and Company, Limited, 36 Essex-street, London, W.C.2.* (10*s.* 6*d.*)

The materials with which the geologist and the engineer have to deal have mechanical properties which cannot always be represented simply by Hooke's law of elasticity. Ductile metals deform permanently under excessive stresses and subsequently rupture, while geological faults in the Earth's crust represent shear fracture in compression or brittle fracture across lines of great tension. Even so, much of the preliminary analysis of stress and strain on which the classical theory of elasticity is based is applicable also to materials whose behaviour is far from perfectly elastic.

In his book, Professor Jaeger presents a full and detailed mathematical analysis of stress and of strain without making any preliminary assumptions about the kind of physical law which relates the two. He then proceeds, from this foundation, to introduce the reader, not only to ideally elastic solids, but also to materials which fail by fracture or by plastic flow when severely stressed, and to materials which have at the same time some of the properties of an elastic solid and some of the properties of a viscous liquid. The discussion, as illustrations of different kinds of behaviour, of such varied topics as the use of a stress function in plane elastic strain, the flow of a Bingham plastic solid in a pipe and between rotating coaxial cylinders, the transmission of primary and secondary earthquake waves and Rayleigh surface waves in an elastic Earth, and the construction of the slip lines in the two-dimensional flow of a perfectly plastic solid in compression between parallel rough plates, all within the space of a short monograph starting from first principles, is a remarkable achievement.

The logical argument involved in each stage of the development of the theory is given fully in a clear, easily readable style. Nowhere is the reader left in doubt as to where the next step comes from, not even, for example, in the neces-

sarily somewhat involved explanation of the use of Mohr's circular diagram in describing a state of stress in three dimensions or in discussing Mohr's theory of fracture. Where a physical condition, such as Tresca's or von Mises's yield criterion, is required in several different mathematical forms for later reference, all these are derived and stated explicitly—without, however, any impression being created that there is needless repetition. This feature, together with a very high standard of accuracy (and a noteworthy absence of misprints of any consequence) helps to make the book potentially a most useful work of reference on points of detail in the elementary mathematical formulation of deformation and flow problems. Fuller discussion, in other works, of various aspects of the theory is referred to in footnotes, but the main text is self-contained without such references.

Certain aspects of the presentation given in this book are, however, open to criticism by serious students of rheological theory—on points which the practical engineer may not consider to be very important. If we regard the book as departing from engineering practice in an attempt to integrate the theories of elastic deformation and viscous and plastic flow into a single subject of study, presenting to the engineer the need for examining materials whose response to applied stress is complicated, we must find fault with it for following too closely the traditional notation and conventions of text-books on idealised elasticity for engineers, which are not necessarily the best for a study of materials in general. Here is an illustration The definition which is given for strain components (not restricted to be small) essentially relates the deformation to the configuration of a small piece of material in its initial, unstrained state. There is, however, a complete duality between the unstrained and the strained configurations, and it is equally possible to relate the deformation to the strained configuration. The distinction is not important in practice when only infinitesimal rotations and strains occur, but it must be made when finite strains and rotations are likely to occur, as in plastic flow, and may then be important.

The discussion of finite strain in the monograph (which is a perfectly correct analysis) stops short of the point where finite strains are directly related to stresses in any material. The flow problems which are discussed and which necessarily involve finite strains, can be formulated in terms of the (much simpler) components of rate-of-strain alone. The question is whether the given definitions of finite strain components could be readily used to extend the theory without landing the reader in some quite unnecessary mathematical difficulties, or whether it is starting him off on the wrong tack.

With this mild caution to the reader who may wish to use the monograph as a basis for the study of still more complicated rheological behaviour, the book can be recommended as a sound and clear account of the elementary theory of deformation and flow, admirably suitable for the geologist and the engineer, and worthy of the attention also of the physicist or the applied mathematician looking for a first introductory account of the theory of the general deformation of solids.

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NEW BOOKS

Some of the books noticed here are selected for extended review in ENGINEERING.

An Encyclopaedia of the Iron and Steel Industry. Compiled by A. K. OSBORNE. *The Technical Press, Limited, 1 Justice-walk, London, S.W.3.* (90*s*.)

The purpose of this encyclopaedia is to provide a concise description of the materials, plant, tools and processes used in the iron and steel industry, and in those industries closely allied to it, from the preparation of the ore, down to the finished product; and to define the technical terms employed. While the book does not attempt to deal at length with any particular subject, it contains a reference to all the topics met by the author in a search of the relative literature extending over a period of nearly 30 years. It provides the specialist with information on subjects bordering his own field and the text, and the comprehensive bibliography, will be of assistance to students of metallurgy.

National Coal Board—The First Ten Years. A Review of the First Decade of the Nationalised Coal Mining Industry in Great Britain. *The Colliery Guardian Company, Limited, 30-31 Furnival-street, Holborn, London, E.C.4.* (21*s*.)

It is stated in the foreword of this book, which has been edited by Sir Guy Nott-Bower, K.B.E., and Mr. R. H. Walkerdine, that now that the nationalisation of the coal mines is well past the experimental stage " it seems desirable that a record of the purpose and of the manner in which it was carried out should be prepared while the knowledge of these remains fresh in human memory." The book opens with an article on " The Purpose of Nationalisation," by the Rt. Hon. Emanuel Shinwell, P.C., M.P.; then follow chapters on various technical, industrial and commercial aspects of coal mining, such as haulage and handling, demand and supplies, coal-face machinery developments, coal preparation, research, scientific control, and health and safety. In all cases the authors are authorities on their particular subject.

Lexique Technique Français-Anglais. By GUY MALGORN. *Gauthier-Villars, 55 Quai des Grands-Augustins, Paris (6e), France.* (2,400 francs.)

This dictionary is the companion volume of the *Lexique Technique Anglais-Français*, now in its fourth edition, by the same author. The ground covered and the treatment are similar. After 23 pages of conversion factors and tables, the dictionary deals with the English equivalents of French words and terms employed in the machine-tool, internal-combustion engine, mining and radio industries, and in public works, aviation, electrical engineering, naval architecture, metallurgy, and other branches of technology.

Lexique Technique Anglais-Français. By GUY MALGORN. Fourth Edition. *Gauthier-Villars, 55 Quai des Grands-Augustins, Paris (6e), France.* (2,400 francs.)

The fourth edition of this technical dictionary has been revised and many new terms have been added, particularly in connection with jet aircraft, electronics, public works and petroleum. The dictionary covers also terms used in the machine-tool industry, mining, the internal-combustion engine industry, electrical engineering, radio, naval architecture, metallurgy, chemistry, and other branches of technology. The first 30 pages of the book consist of conversion factors and tables, relating to weights and measures, physical units, screw threads and other quantities of interest to engineers.

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TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Soldering of Aluminium Cables. ALUMINIUM UNION LIMITED, The Adelphi, John Adam-street, London, W.C.2. Practical notes on the fundamentals of the problem of soldering aluminium and detailed and illustrated instructions on how to make all the normal types of joint. The methods of soldering aluminium conductors and aluminium cable sheathes are described, and lists of suppliers of all the necessary materials and comprehensive quick-reference current tables for aluminium cables are included. An 84 page publication containing numerous line and half-tone illustrations.

Water Power Equipment. GILBERT GILKES AND GORDON LTD., Kendal, Westmorland. Water turbines, turbine governors and self-priming pumps. Booklet entitled " On the Development of Water Power ", discusses in general terms the choice of turbines; an introductory text-book, with data tables, on modern water-power practice.

Metallurgical Laboratory Equipment. SHANDON SCIENTIFIC CO. LTD., 6 Cromwell-place, London, S.W.7. Description of the firm's two-speed grinder-polisher for the wet or dry preparation of metallurgical specimens, polishing benches, abrasive papers and cloths, and other laboratory apparatus for the metallurgist. Illustrated " News-Letter."

Nitrogen Generators. W. C. HOLMES & CO. LTD., P.O. Box B7, Turnbridge, Huddersfield. Holmes-Kemp nitrogen generators employing a combustion process. Models available for town's gas, coke-oven gas, propane or butane. Capacities from 1,000 to 20,000 cub. ft. per hour of nitrogen. Publication No. 65 gives details.

Carbon Dioxide Tester. JAMES GORDON & CO. LTD., Dalston-gardens, Stanmore, Middlesex. " Mono " portable carbon dioxide tester for gas sampling. Percentage of CO_2 is shown directly on a dial, which is operated by the vacuum caused by the absorption of carbon dioxide in caustic potash. Illustrated leaflet.

Repairs of Broken Parts by Welding. BARIMAR LTD., 22-24 Peterborough-road, Fulham, London, S.W.6. Typical instances of broken engine bedplates, casings, cylinder covers, cylinder heads, gearwheels, crankshafts, and other components and equipment quickly and efficiently repaired by welding. Illustrated booklet.

Railway Signals. HEYES & CO. LTD., 11 John-street, London, W.C.1. The " Wigan " signalling system for underground locomotive installations. Three-aspect signals (red, amber and green) are controlled by vehicle-actuated switches placed at appropriate positions on the track. Illustrated leaflet.

Aluminium Casting Alloys. ALAR LTD., 3 Albemarle-street, London, W.1. Information regarding the chemical composition, mechanical and physical properties, various other characteristics, and applications of LM8 and LM24 aluminium casting alloys. Individual data sheets.

Hard-Facing Material. DELORO STELLITE LTD., Highlands-road, Shirley, Solihull, Warwickshire. A few of many applications of Stellite, including the blanking of dies, the tipping of tools and the production of blade tips for parting tools, are dealt with in illustrated leaflets.

Shop and Display Lighting. A.E.I. LAMP AND LIGHTING CO. LTD., Crown House, Aldwych, London, W.C.2. Lighting fittings particularly for shop and display purposes, including both filament and fluorescent types. Also types of trunking for ceiling runs. Catalogue.

Coal Preparation Plant. SIMON-CARVES LTD., Cheadle Heath, Stockport. Baum-jig coal preparation plant in which coal from 2 in. to zero is washed in one stage. Brochure giving full description of recent plant, including flow diagrams and details of automatic shale discharge machines.

Air Filter. STURTEVANT ENGINEERING CO. LTD., Southern House, Cannon-street, London, E.C.4. " Precipitron " electrostatic air filter. Booklet outlines atmospheric pollution problem in general, gives table of dust sizes, and describes installation and use of system. Publication 7106.

Sealing Joints. EXPANDITE LTD., Chase-road, London, N.W.10. Fillers and sealing compounds to accommodate movements in the joints of civil engineering and building structures, including roads and runways. Also for sealing joints in coachwork in the motor industry. Illustrated booklet.

Grinding Wheel Dressers. DANITE HARD METALS LTD., Danite Works, Carr-hill, Doncaster. " Diard " wheel dressers of diamond and boron carbide mixture embedded in carbide matrix. Four standard sizes with square or round tips. Leaflet.

Springs. ALCO PRODUCTS INC., Schenectady 5, N.Y., U.S.A. Hot and cold-wound steel springs of all types and for all purposes. Descriptive brochure includes formulae for helical, volute and Belleville disc types as well as a table of physical properties.

Folding Machines. F. J. EDWARDS LTD., 359-361 Euston-road, London, N.W.1. Box and pan folding machines for steel plate up to 14 s.w.g. Three models, 48 in., 72 in. and 96 in. wide, all with adjustable fingers. Brochure No. 32C.

P.V.C. Fans. KEITH BLACKMAN LTD., Mill Mead-road, London, N.17. Polyvinylchloride fans with 6 in. and 12 in. diameter impellers, forming the series I division of the total range now being made. Leaflet.

Industrial Lighting. A.E.I. LAMP AND LIGHTING CO. LTD., Crown House, Aldwych, London, W.C.2. Lighting fittings for industrial premises, including floodlights and hand lamps. Both tungsten and discharge types. Illustrated catalogue.

Air Compressor. CLIMAX ROCK DRILL AND ENGINEERING WORKS LTD., Carn Brea, Redruth, Cornwall. Instruction and maintenance manual for the F.80A Mark IV portable air compressor. Publication No. 201.

Plastics Products. BX PLASTICS LTD., Higham Station-avenue, London, E.4. Particulars of the qualities and applications of Cobex rigid vinyl sheet and Bextrene toughened polystyrene sheet. Illustrated folders.

Water Taps. PEGLERS LTD., Belmont Works, Doncaster. Taps and fittings for basins, sinks or baths. Including dual-flow and mixing units, and waste and overflow fittings. Illustrated catalogue.

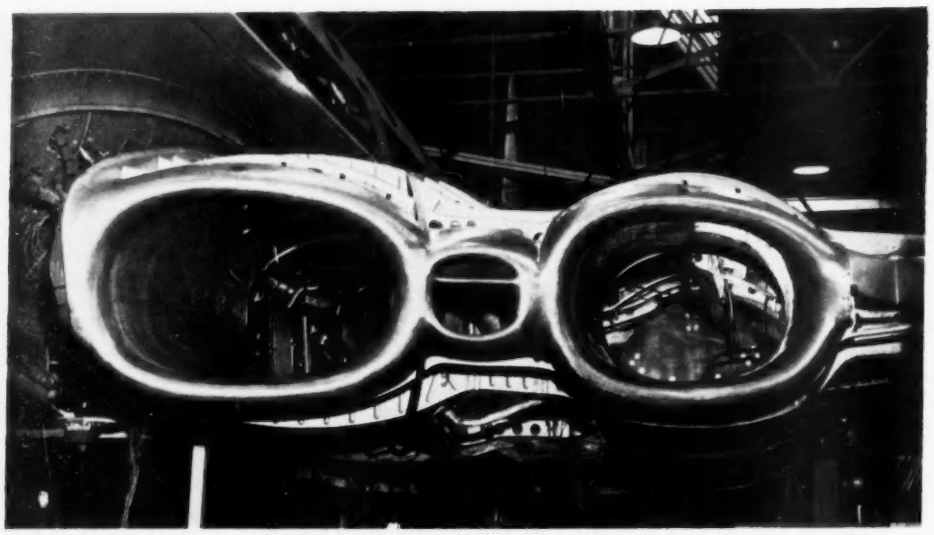

Fig. 1 The port air intakes for the RA29 engines being installed in the Comet 3. The upper half of the centrally placed scoop feeds cooling air to the rectifier, while the lower half supplies air to the heat exchanger for the cabin air-conditioning system.

COMET 4 ENGINES INSTALLED IN COMET 3

Shown in Fig. 1 are the Comet 3's new air intakes (port) designed to take the 10,500 lb. thrust Rolls-Royce RA29 turbojets that are to power the production Comet 4 and 4A air liners. Thus fitted, most of the certification flying for the Comet 4 can be carried out on the existing Comet 3.

The new engine bays are identical with those of the production aircraft, and incorporate titanium firewalls and high-efficiency air intakes that have been extensively developed from full-scale tunnel tests. Through the lower part of the central scoop, between the two intakes, air is led to the cabin air-conditioning heat exchanger. The upper part of the scoop leads cooling air to the rectifier.

Each engine is supported at four points, and the mounting incorporates quick-release joints for all fuel and electrical connections, enabling an engine change to be completed in about an hour. In mounting the tailpipe of the engine, provision has been made for the fitting of reverse thrust. An RA29 engine awaiting installation can be seen in Fig. 2; this illustration shows clearly the variable inlet guide vanes. The two large pipes on either side of the engine lead hot air from the rear of the casing to the intake for de-icing purposes. All the accessories are directly driven, and are mounted below the engine. In the Comet installation they can readily be reached for servicing, through an access door in the bottom wing skin, from ground level.

Among the improvements which are being incorporated in the production Comets are an improved control system, embodying air-load "feel" in the elevator circuit, better instrumentation and the most modern radio equipment, and developments in the de-icing and air-conditioning systems.

Major work has been undertaken to render the Comet 4A aircraft virtually independent of ground equipment at intermediate traffic halts. An auxiliary power unit will be incorporated to supply self-contained power for engine starting and ancillary services, and will be capable of operating the refrigerated air-conditioning system on the ground. Folding access stairs will be built into the cabin entrance.

The de Havilland Aircraft Company, Limited, consider that the technical and engineering requirements laid down by the Air Registration Board have now been satisfied, and that the requirements of the United States Civil Aviation Authority—still not finalised—" appear to present no insurmountable problems." Much of the certification programme can be completed before the Comet 4 flies this year.

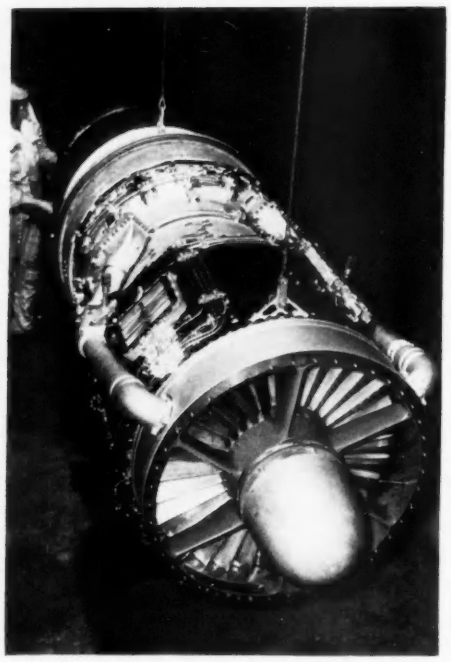

Fig. 2 The Avon RA29 engine, showing the slinging points and the two forward mounting spigots. The two large pipes on either side of the engine conduct hot air from the rear of the compressor for engine de-icing purposes. The air-intake support struts and the variable inlet guide vanes are clearly visible.

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HIGH-TENSION SUBMERSIBLE PUMP SET

Examination After Two Years Running

A successful high-tension wet-type submersible motor is essential if large submersible motors are to be used for pumping from considerable depths. Cable for low-tension motors is bulky and expensive, and calls for careful handling when the set is being raised or lowered. For a 450 h.p. low-tension submersible motor installed 1,000 ft. below ground surface, the cost of the cable in the shaft is about 140 per cent. of the cost of the motor. Power loss may also have an appreciable effect on the overall efficiency of the installation when the cable is of the low-tension type. If, on the other hand, a high-tension motor is used, it is possible to have a cable which will give minimum running costs and at the same time show very appreciable savings in first cost.

USE IN COAL MINES

The first high-tension wet-type submersible pump set to be installed in Great Britain was designed and built by the Harland Engineering Company, Limited, Alloa, and put to work in the Castle Pit, in the National Coal Board's South Western Division, in 1954. The pump part of the set is of conventional design; only the motor has unusual features. It is rated at 250 h.p. at 1,460 r.p.m., with current at 3,000/3,300 volts. The pump duties are 600 gallons per minute at 835 ft. head, and 800 gallons per minute at 650 ft. head. The complete pump set was described and illustrated in ENGINEERING, October 15, 1954, page 494.

After about 17,000 hours in the pit the pump set was lifted and subjected to a detailed examination. Under normal conditions the flow of water into the pit is such that the pump motor does not need to run continuously, and the actual running time when the set was lifted was about 9,000 hours, or 53 per cent. of the total length of service. The pump set has therefore had a considerable number of stops and starts, and has, in fact, been used in a very typical mine drainage application.

Experience with low-tension motors had shown that polyvinyl chloride covered wire was the best material for the stator windings. This material was used in the high-tension motor, and together with the specially designed joint sealing has proved completely successful. No trouble was experienced during the two years operation of the pump set, and a check measurement of the insulation showed no change in value since the machine was manufactured.

NEGLIGIBLE BEARING WEAR

The thrust bearing consists of a stainless steel collar and carbon pads. The bearing is water-lubricated, and in addition to being used normally when the pump is running, it runs in reverse for a few minutes every time the pump is shut down, since there is no foot-valve, and the pump runs as a turbine until the rising main is empty. At the time when the motor was installed it was realised that it was doubtful if true hydro-dynamic film lubrication could exist, in view of the operating conditions, and that a certain amount of rubbing must occur. Nevertheless, it was believed that wear would be negligible, and experience has confirmed this belief. No measurable wear was found in the carbon pads or on the steel collar, though one or two pads had slight score marks. The journal bearings are also of carbon, and these, too, were found to be in excellent condition.

The satisfactory state of the bearings is due largely to the effectiveness of the shaft sealing. This consists of a carbon ring pressed against a thrust collar by a spring, the collar being so shaped that any sediment falling on to the top of the motor is deflected from the seal. Evidence of the effectiveness of the seal was provided by the absence of any deposit in the motor. Quite a heavy deposit had built up inside the rising main, and if there had been any considerable interchange between the mine water and the water inside the motor (which was originally filled with distilled water), a deposit would have built up there to such an extent that it would have prevented the motor from running. The fact that no such trouble occurred, and that no trace of deposit was found in the motor can be taken as clear proof of the satisfactory functioning of the shaft seal.

The examination showed the pump set to have done all that it was designed to do, and after a general servicing it was re-installed in the pit. Since then it has run for a further 2,500 hours without giving any trouble at all.

CONVEYORS FOR CURVES

High Bulk Capacity

Steel conveyors, capable of negotiating curves and of carrying such materials as dry sand up gradients of 32 deg. are now being made under licence in this country by Wharton Engineers (Elstree), Limited, Watford-road, Elstree, Hertfordshire. Brief mention was made of them in our article on the 1956 Mechanical Handling Exhibition (ENGINEERING, vol. 181, page 377, 1956). They consist of a series of overlapping curved steel pans attached each to the other by a centrally positioned steel-linked driving chain, which is located below rail level. Brackets are fitted to the steel pans at given intervals. To these brackets are bolted spindles carrying rollers mounted on anti-friction bearings, with seals eliminating the need for re-greasing. These rollers move with the pans on a track which is made from standard narrow-gauge rails; the driving chain is protected from damage by its central position, together with the overlapping of the pans.

The curved design of the steel pans allows a high bulk carrying capacity in relation to the width; this curvature together with the overlapping of the pans and the centrally placed driving chain permits the conveyors to operate round bends in either direction. The change from straight to curved operation requires only a given number of swivel links in the driving chain

Fig. 1 Made of steel sections and driven by a central chain, the W.S. conveyor can carry materials at temperatures of 700 deg. C. round curves or up slopes of 32 deg.

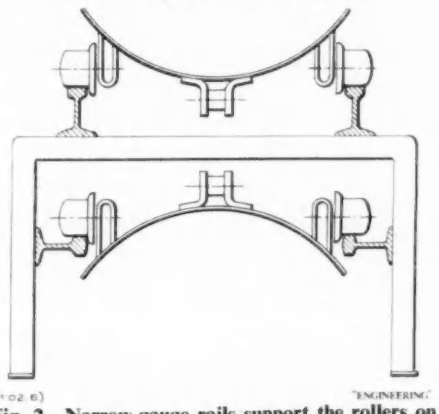

Fig. 2 Narrow-gauge rails support the rollers on which the curved sections are mounted.

and the bending of the rails to give the necessary curve.

The conveyors are impervious to climatic conditions and can operate under water if required; the steel pans are not susceptible to damage by rocks, tramp iron or other heavy rough material and experience has shown that loss between the flanges of the pans, when operating with fine materials, is negligible. Materials as hot as 700 deg. C. can safely be handled.

Fig. 1 shows a section of the complete conveyor and Fig. 2 a diagrammatic arrangement of the construction. The return portion runs immediately below the load-bearing section. Where angles of elevation greater than 32 deg. are desired, flights can be added to the pans to retain the material.

The conveyors are operated by electric motor through a worm drive, transfer box and final reduction by chain and sprocket to the sprocket shaft of the head unit. The tail unit incorporates an idler sprocket with adjustments for tensioning the driving chain. The frame joining the head and tail units is of rugged construction consisting of two sets of rails, one set carrying the loaded belt and the other the empty return belt. These rails are firmly clamped to support bridges fabricated from steel angle.

At present three sizes are being made; the largest, type W.S.10, has pans 22 in. wide, the type W.S.20 pans 13 in. wide and the type W.S.30 pans 9 in. wide. For purpose of comparison the output of the W.S.10 is similar to that of a 42 in. wide troughed rubber belt operating at the same speed, the W.S.30 being comparable with an 18 in. rubber belt.

The type W.S.30 has also been adapted for use as a portable elevator, produced in a short length and mounted on a wheeled chassis capable of operation at any angle from horizontal to 60 deg. of elevation.

TRANSATLANTIC TELEPHONE LINK

DEEP SEA CABLE DISCUSSED AT INTER-CONTINENTAL MEETING

Papers describing the design, manufacture and installation of the first transatlantic telephone cable system were presented at a meeting of the Institution of Electrical Engineers on January 24. This meeting was also " attended " by members of the American Institute of Electrical Engineers in New York and of the Engineering Institute of Canada in Montreal, this annihilation of space having been made possible by the use of the cable itself. As has been the case with numerous broadcast programmes recently, transmission on this occasion was satisfactory, amply illustrating the skill of those who have been concerned in carrying out the work in the laboratory, in the factory and at sea.

The papers provide a useful collection of technical information on an engineering achievement of international importance. Though such a means of communication has been considered for the past 30 years, it stems principally from negotiations which were begun in 1952 between the American Telephone and Telegraph Company and the British Post Office. That over 4,000 miles of cable with its associated submerged repeaters and terminal equipment should have been designed, manufactured, laid and placed in successful operation in the short period of four years is a feat itself worthy of recording.

Since the service through the cable was opened to the public at the end of September, traffic in both directions has greatly increased from both commercial and domestic sources with good financial results. This is, of course, mainly due to the higher reliability and greater clarity of the transmission and may be illustrated by saying that a total of about 4,000 calls are being made each day between London and New York, an increase over the previous figures by radio of 80 per cent. Between London and Montreal the increase has been even greater, and has amounted to as much as 1,250 calls per day, an increase of 150 per cent. During the afternoon peak period, the 35 voice channels are often working to full capacity, a proportion initiating from the Continent, for which London acts as the European switching centre.

SUBMERGED REPEATERS

Introducing the formal papers, Dr. M. J. Kelly and Sir Gordon Radley pointed out that a coaxial cable was necessary for the transmission of the wide frequency band width required for the numerous telephone channels. The great difference between the transatlantic telephone cable and the earlier transatlantic telegraph cables was the inclusion of submerged repeaters at equally spaced intervals and the use of two separate cables in the long intercontinental section so as to provide a separate transmission path for each direction. At the working frequency range of 144 kilocycles, 35 telephone channels and one telegraph channel were available in each cable. There were some 300 valves and 6,000 components in the submerged repeaters, many of which had been laid at depths exceeding 2,000 fathoms.

For reasons of reliability the valves used in the repeaters between Newfoundland and Scotland had a mutual conductance of only 1,000 micromhos, but between Newfoundland and Nova Scotia the corresponding value was 6,000 micromhos. It was to be expected that future long repeatered cable systems would use valves of the latter performance, thus assisting the provision of a greater number of circuits. The development of transistors with their lower power drain and operating voltage would enable many more repeaters to be used than at present and thus permit the transmission band to be further widened.

PLANNING AND PERFORMANCE

In a paper on planning and overall performance, Messrs. E. T. Mottram, R. J. Halsey, J. W. Emling and R. G. Griffith said that the system had been designed as a connecting link between the North American and European long-distance network. The broad objective had been to add as little loss and other forms of impairment as was possible. For this reason the standards of international telephone circuits, as defined by the International Consultative Committee on Telephony (C.C.I.F.), had been adopted. These requirements had had to be met on a system which for 2,000 miles of its length could not be altered to the slightest extent once it had been laid, and its successful operation since it was placed in operation on September 25, 1956, was a measure of the realism of the early planning.

Dealing with that portion of the system which lay between Newfoundland and Scotland, Messrs. H. A. Lewis, R. S. Tucker, G. H. Lovell and J. M. Fraser pointed out that as it was supplied with power from both ends the maximum number of repeaters, and thus their spacing, was determined by the direct-current voltage. With the repeater spacing and the type of cable both fixed, the frequency band that could be utilised depended on gain/band-width limitations, signal power capacity and signal/noise requirements. These limitations had resulted in the decision to develop a system of 4 kilocycle carrier spacing utilising the 20 to 164 kilocycle band. The design of the 51 repeaters in each cable was based on a system length of 1,955 nautical miles, the spacing being about 37·4 nautical miles for the east-bound and 37·6 nautical miles for the west-bound cable. The number of channels which could be transmitted was determined by the upper and lower boundary frequencies.

REPEATER DESIGN

The design of the repeaters for the North Atlantic link was described in a paper by Messrs. T. F. Gleichmann, A. H. Lince, M. C. Wooley and F. J. Braga. They consisted of a flexible unit which contained the thermionic valves and other circuit components and a waterproof enclosure and seals. The repeater unit was a three-stage feed-back amplifier of conventional design with the cathodes at alternating-current

earth potential and was connected to the cable through input and output coupling networks. Each coupling network consisted of a transformer plus gain-shaping elements and a power-separation inductor. There were also two feed-back networks and two inter-stage networks; the latter were of conventional design, their gain shaping being such that the feed back was approximately flat across the frequency band. Anode and heater power were supplied over the cable. The direct-current circuits were isolated from the container by high-voltage blocking capacitors.

To provide a flexible structure the repeater was assembled in 17 longitudinal sections, which were mechanically coupled by helical springs and electrically interconnected by " bus " tapes. The sections consisted of circuit components mounted in machined plastic forms and enclosed in a plastic container, which was placed in a housing of the same material. The " bus " tapes were laid in grooves milled in the outer surfaces of the section containers, in the ends of which wiring spaces were machined for connecting the network leads. The " buses " consisted of two copper tapes in parallel to guard against open circuit should one break. The housing was placed over the container and " buses " and was closed by a plastic coupler plate, which was fastened to the housing by plastic pins.

The repeaters contained a total of about 6,000 resistors, capacitors, inductors and transformers. Fortunately, only the capacitors had a life limited by time and severity of operating conditions. Tests showed that none of the usual solid or semi-solid materials employed to impregnate paper capacitors were suitable for continuous use at sea-bottom temperatures and castor-oil-impregnated Kraft paper was therefore chosen as a dielectric. Stability was assured by only using existing structures which had long records of satisfactory performance.

REPEATER PRODUCTION

Messrs. H. A. Lamb and W. W. Heffner pointed out that the production of submarine telephone cable repeaters, designed to have a minimum trouble-free life of 20 years under conditions where maintenance was impossible and replacement expensive, required many new manufacturing procedures. These included care in the selection and training of the personnel and manufacturing environment. Inspection and testing were also of great importance.

These points were illustrated by a description of the one-storey building, with a gross area of 43,700 sq. ft., which had been selected for the purpose in Hillside, New Jersey. This was fully air-conditioned, the temperature being generally controlled within 73 deg. to 77 deg. F. Relative humidity was maintained at a maximum of 40 per cent. in all areas, except in capacitor winding rooms where the maximum was 20 per cent. to avoid mechanical difficulty with the paper. All the working areas, with the exception of the repeater enclosure area, were separated from each other and the walls from about 4 ft. above the floor were entirely of reinforced glass. Great care was taken to avoid contamination of the product by the use of special clothing, washing and vacuum drying of the areas at regular intervals and daily dust counts.

POWER SUPPLY

In a paper by Messrs. G. W. Meszaros and H. H. Spencer it was pointed out that the direct-current power for the repeaters was obtained from plant at both cable terminals. This consisted of a three-phase induction motor, supplied from the mains, and driving a self-excited single phase 230 volt alternator and a 130 volt direct-current motor. A stand-by set running at no load was also provided. This equipment was reinforced by two similar sets, which were supplied through separate mains and by a fifth motor-alternator which could be used when any of the other sets were out of service for maintenance and repair. The alternator output was supplied to an auto-transformer where its voltage was stepped up before being rectified in a bank of five rectifiers to produce direct-current at 2,750 volts.

The system was equipped with the highest possible degree of protection to guard against excessive currents and voltages under a wide variety of fault conditions. Regulation of the direct-current voltage permitted precise transmission levels to be obtained and assured the maximum life of the repeater valves.

NEWFOUNDLAND-NOVA SCOTIA LINK

A paper by Messrs. J. O. McNally, G. H. Metson, E. A. Veazie and M. F. Holmes described the valve, which had been designed by the British Post Office Research Station for use on the section between Nova Scotia and Newfoundland. This was a development of the 6P12 valve, which had been installed in the Aberdeen-Bergen cable. The design and manufacture of the cable laid between Newfoundland and Scotland, details of which have already been published in ENGINEERING, were dealt with by Messrs. A. W. Lebert, H. B. Fischer and M. C. Biskeborn, who also gave an account of the way the transmission characteristics were controlled and of the electrical, attenuation and pulse echo measurements made.

The design and engineering of that part of the transatlantic telephone cable system, which lies between Newfoundland and Nova Scotia, and was the responsibility of the British Post Office, were described by Messrs. R. J. Halsey and J. F. Bampton. The repeaters were rigid units approximately cylindrical in shape, 9 ft. long and 10½ in. maximum diameter. They were arranged for both way transmission through a common amplifier which had two forward paths in parallel with a single feed-back path. The two halves of the amplifier were arranged so that practically any component could fail in one without affecting the other. They were energised by constant-current direct-current between the centre conductor and earth. The cable used was essentially the same in design as the main cable.

The design and production of the 16 submerged repeaters on this link were dealt with in detail by Messrs. R. A. Brockbank, D. C. Walker and V. G. Welsby. Each had a gain of 60 decibels at 552 kilocycles and the amplifier consisted of two forward amplifying paths with a common feed-back network. As reliability was of paramount importance production was carried out in an air-conditioned building with meticulous attention to cleanliness and rigid manufacturing and testing specifications. Details of the method of supplying power used on this part of the system were given by Messrs. J. F. P. Thomas and R. Kelly. It was based on the use of electronic-electromagnetic equipment which ensured an uninterrupted supply to the repeaters unless there was a failure at both ends of the link. As this was a remote possibility reliability was greatly increased.

ROUTE SELECTION AND CABLE LAYING

In a final paper by Messrs. J. S. Jack, W. H. Leech and H. A. Lewis the factors entering into the selection of the route for the cable were considered and the planning and execution of the laying task were described. Details were given of the modifications it was necessary to make in the equipment of H.M.T.S. Monarch, which was used for laying, owing to the presence of the repeaters in the cable. Some account was given of the tests that were made while laying was taking place.

EUROPE'S MOTOR INDUSTRY

A NEW STUDY OF THE COMPETITIVE POSITION

By Gordon Wilkins

Interesting light is shown on the relative competitive capacity of the various sectors of the West European motor industry by a paper read before the Society of Automotive Engineers in Detroit by Laurence Pomeroy, technical editor of *The Motor*. The whole West European industry makes fewer cars than the General Motors organisation alone, but concentration has proceeded some way within the limitations imposed by national frontiers; in 1955 General Motors made 3·9 million cars, Ford, U.S.A., 2¼ million, and Chrysler 1·3 million, but next comes the B.M.C. with 350,770 and Volkswagen with 290,000.

An over-simplified picture of American production is often quoted to show that Britain makes too many models. In fact, Chevrolet alone is offering 20 separate models for 1957, with one six-cylinder engine, and two sizes of V8 in various combinations of carburetter and compression ratio. The buyer has a choice of four transmissions, and there are sufficient colour options to give a choice of 480 different vehicles. Britain's production may be the most diversified in the world, but Mr. Pomeroy shows that 90 per cent. of British output is based upon 11 different engines and 21 types of body or hull.

Western Europe still has great potential for development as a car market, for with a population 47 per cent. higher than that of the United States, it has a little over one-fifth the number of cars in use. However, road mileage (36 per cent. of U.S.A.) is a limiting factor, and both the United Kingdom and Germany already have substantially more vehicles per mile than the United States. The power available to the European worker is lower, and productivity is about half that in America, but on a basis of cost per pound, West European cars do not show up too badly, averaging 70 cents against 60 cents for an average American car.

Figures quoted by Mr. Pomeroy show how the world's export trade is predominantly in small cars, which is why the United States, from contributing 86·5 per cent. of the world's exports in 1928, is now a net importer of cars in relation to Europe. The influence of size on sales is illustrated by reference to the Swiss market, where, taking the American and German products of General Motors, halving the price quadruples the sales, despite a two-thirds reduction in power. Volkswagen has seven times the sales of Chevrolet; the car has 75 per cent. less power but is 60 per cent. cheaper. Of all car-producing nations, Britain is by far the best at selling a variety of sizes, whereas both France and Germany concentrate heavily on small cars.

The prosperity of the European vehicle market has surprised many observers, and has certainly been under-estimated by the British industry. It is to be feared that the United States, no longer able to export its own cars in significant quantities, will redouble its efforts to dominate European production. Already Ford and Vauxhall represent a large and growing challenge to the B.M.C., and in Germany it is only the vigour of Volkswagen, directed by an American-trained engineer, which prevents Opel, the General Motors subsidiary, from holding first place.

Although salaries in the British industry have not risen out of proportion to those in the rest of Western Europe, our wage rates are now high enough to cause some doubts about our ability to compete effectively within the framework of a common European market, but Mr. Pomeroy shows that the balance is to some extent redressed by the higher payments for social security and other fringe benefits to which European producers are committed. The B.M.C. have to add to the wage bill 4 per cent. for state social security and a further 4 per cent. for pensions and other welfare schemes, plus contributions to canteens, sports facilities, etc. In the nationalised French

Renault organisation, state social security, plus many special benefits such as cash bonuses, pensions, training schemes, holiday camps, creches, and a housing programme which will provide 3,500 units by the end of 1957, add no less than 47 per cent. to the wage bill. Moreover, holidays help to bring a French factory to a standstill for 137 days per annum, against 120 in Great Britain. Despite this, Renault wages in 1955 averaged £714 per head, and 1 worker in 10 was able to own a Renault car. The French motor industry consistently complains that its export performance is retarded by high social security costs, and these figures lend some support to the argument.

German state social security adds 10·4 per cent. to the wage bill, and Daimler Benz set aside a further £2·1 million for cash bonuses, subsidised holidays, and pensions on behalf of 46,000 employees. Volkswagen spend about £2·5 million a year over and above wages and salaries, much of it on a housing programme which is producing about 900 units a year. Fringe benefits figure still more largely in the Italian industrial scene. The Fiat worker's pay represents only 55 per cent. of his cost to the company, the rest being spent on ambitious schemes of medical care including hospitals and maternity homes staffed by 600 doctors and surgeons to care for 177,000 employees and dependents. Holiday camps and convalescent homes, training schools and an extensive housing programme raise the total cost to some £5 million a year.

Another interesting line of inquiry pursued by Mr. Pomeroy is the proportion of monthly salaried office staff to the total number of workers in the various factories. The results for the largest producers are as follows: B.M.C., 2·4 per cent.; Ford G.B., 10 per cent.; Vauxhall, 10·5 per cent.; Standard, 4·8 per cent.; Volkswagen, 9·5 per cent.; Daimler-Benz, 18 per cent.; Auto-Union, 25 per cent.; Fiat, 20 per cent. In commenting on these figures, Mr. Pomeroy points out that British car builders are much less self-sufficient than those on the Continent, buying out body pressings, castings and forgings besides a large range of components; they therefore profit from research and development work done by suppliers (Joseph Lucas is credited with a capital value equal to Standard and Rootes combined, and S. Smith and Sons equal to Rootes), but some of the figures may also reflect the shortage of trained engineers, and the inadequate level of research and development which was accepted as normal until quite recently.

Figures for the first nine months of 1956 show that, even before the Suez crisis, output and exports of the British motor industry had declined by some 17 per cent., while those of all other European producers had risen sharply. The author comments "Although successful in the primary purpose of securing foreign currency, the Socialist export-first policy has left 1½ million pre-1939 cars (about 50 per cent. of the total) on the British roads, and a legacy of sales resistany in many parts of the world wherein the British cars produced between 1947 and 1952 proved a disappointment." These misfortunes have since been supplemented by government policy at home, and sales restrictions in the vulnerable Commonwealth markets on which the industry had come to depend excessively. Mr. Macmillan's act in increasing the petrol tax suggests that the industry has little to hope for from his new government, but it seems to be addressing itself with some vigour to the restoration of a correct balance in its exports, despite the abnormal difficulties of the present time.

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METALS IN BUILDINGS

A whole-day symposium on "Corrosion of Metals in Buildings", arranged by the Society of Chemical Industry, 14 Belgrave-square, London, S.W.1, will be held at the Institution of Civil Engineers, Great George-street, S.W.1, on March 21, next.

HOW TO USE MARKET RESEARCH

Prepared by Engineering Information Service

The function of market research and the principal techniques used in surveying markets for engineering goods were examined in an earlier article—"Market Research Comes First," ENGINEERING, December 14, 1956, page 759. Here we are concerned with the applications of the results. They are almost infinite, from the selection of a new development project to the planning of production, purchasing policy or a sales promotion campaign. Only some of the more common uses are therefore discussed in this article. They include not only the application of knowledge to shaping policy, but also the presentation of the knowledge so that it is readily available, for day-to-day use, in company records. Merely filing a market report when it has served its prime object is a waste of effort and money.

Customer Records

One of the pre-requisites of a lively sales force is that it should be well informed. It must know how to use its resources, who are its legitimate quarries, and as much about each as will make the approach easier, better informed, and more fruitful. Most sales managers will agree that first-class industrial intelligence is half the battle.

A survey of the market is an opportunity to establish customer records, or to undertake a basic revision of those in existence. In the case of the instrument company mentioned in the earlier article a mass of data had been obtained concerning customers and potential customers. This was presented in the form of notes on visits given in appendices to the report. The information included the number employed, the principal products, the names of the managing director, chief engineer, chief draughtsman, buyer and plant engineer. Past purchases of instruments were recorded by make and type, generally with the reasons given for the purchase of a particular make. In most cases the instruments were used as components in a range of equipments. These were described and trade leaflets obtained. In many visits reported the prices paid were noted, as was the acceptable delivery delay and those quoted by competitors.

The managing director decided to have this information transcribed into customer record cards, and used as a basis for the design of representative's visit reports so that the information could be kept as up to date as possible. The market survey established that the company had about 600 good potential customers; over half had been visited. Cards were made for all of them, and kept alphabetically, punched for hand-sorting by sales areas, by industries and by principal applications.

Information on Competitors

Almost as much data had been collected on the company's competitors and their products as on the customers. This was supplemented by information available inside the instrument manufacturer's works and sales offices; the Board were amazed to find how much knowledge existed which had never been collated and channeled through the company's executives.

For each competitor cards were made out on which information was recorded concerning products (cross referenced to the trade literature carefully filed in the sales manager's office), such as types, prices and current delivery delays; the principal customers; the methods of distribution in use, such as the agencies, distributors, dealers and the branch offices in the various sales areas.

In this manner the company built up a most comprehensive record of their competitors' activities, resources and products in a readily accessible form. Accessibility is a vital consideration for all records. If they are accessible and entries are neat and easy to read, record cards are used more freely and kept up-to-date.

Knowledge of Suppliers

Few purchasing offices receive information—about suppliers, components and materials—adequate to fulfil their proper functions, which is to buy their companies' requirements at a competitive price and to inform their colleagues in the design office of new products as soon as they become available. Some companies undertake "purchasing surveys" to obtain this information, and this is undoubtedly the best method, though useful information can be obtained through a market survey, if it is planned accordingly.

Users—particularly in the design department—are more than willing to discuss the specifications of the products and materials they incorporate in their designs. Their views can be of considerable assistance when revising specifications, or when setting standards of quality for the guidance of inspectors. A recent study of quality control methods, carried out under the aegis of the British Institute of Management and presented in a paper by Dr. R. M. Belbin, reported in the January 25 issue of ENGINEERING, showed that the standards of quality required by the user were often quite different from those imposed by the supplier in his own inspection department. The consequent high reject rate is a source of waste (and therefore of cost to the user) far too great to neglect with impunity.

Simplifying Design

The reduction of variety in a company's range of products is one of the most important sources of cost reduction open to the average company. The information obtained during a survey of the market for the instruments, made by the company quoted above, showed that a number of the instruments which sold in small numbers and at a loss were in fact only slightly different from the best selling line of a competitor. Both instruments fulfilled the same purpose but one was sold energetically and well and the other barely sold at all even though it had been the leading design in its time (immediately pre-war). Market checks in other countries proved conclusively that this type of instrument could be sold in large quantities, provided it was re-styled and reduced in price. Although the price reduction required was substantial, the economies in production costs made possible by the use of bulk production methods yielded a very good profit margin.

This shows, most conclusively, that a product simplification exercise cannot be carried out on the basis of stock movement only. A company should know which of their products are "loss-carriers," and which of the various parts and components contribute to this state of affairs. At the same time they should test the marketability of such products. It is very easy—particularly when a new costing system is introduced—to price a component or product out of the market. It is equally easy, when the sales representatives handle a wide variety of products for a group of them to be neglected in favour of those easier to sell. No product should be discarded, or increased in price, without up-to-date market knowledge of its potentialities.

Production Planning

Few companies in the more traditional sections of the engineering industry plan production farther ahead than they can see in their order books. Yet the failure to foresee clearly major changes in demand can lead to extremely costly "panic" action—such as suddenly declaring large numbers of workers redundant, or working considerable overtime to cope with a sudden influx of orders, the timing and length of which could have been predicted. Well conducted surveys of the market are the only means open to managements to effect smooth and gradual changes in the rate of production. The sales manager who each month sits down to prepare

a sales forecast to serve as production targets, does so—at best—surrounded by the sales reports of his representatives and agents and facing a sales graph showing actual sales over the past few months or years. He is conscious that the Suez crisis, or the entry of a new manufacturer on a large scale, or the "credit squeeze," or the import restrictions in Australia, will affect his sales. How much he can only guess. Nine times out of ten he will merely extrapolate his graph and read off the result.

But the above is the well-informed, thoughtful sales manager. The average man will not have consolidated sales reports (it is only by reading sales reports in retrospect that it can be seen how difficult it is for a representative to see ahead), and probably will not know the past sales of each product. His sales forecast will be a guess based on his initial appraisal of the situation. It could be very good. Yet it is dangerous to plan buying, stock levels, assembly shop loading, etc., on the basis of a hunch.

Targets and Promotion

From the point of view of the sales manager one of the most valuable aspects of a market survey is the indication it provides of the potential demand in each of his sales areas. To know his own sales in relation to those of his competitors in, say, West Riding of Yorkshire, gives him a yardstick to increase the performance of his area office. He is also given factual information about his competitors' methods—how many representatives they use, how much local advertising, how much of their sales are "traditional," or "on price," or arise from the friendship of the individuals concerned at commercial, technical, or director level.

To know these things is to know what one is up against, and therefore to be in a position to assess the quality of one's own effort. The planning of sales promotion campaigns and their nature is difficult without such knowledge; likewise, the fixing of "targets" for the sales staff to aim at. The tendency to do so without knowledge of the area potential is dangerous. Either it is too low, and may cause sales representatives to relax their efforts (particularly if they are on commission related to the target figure), or too high in which case it is likely to discourage and adversely affect the relations of the sales manager with his field staff.

Economy of Effort

Knowledge of the market should, if properly recorded as suggested at the beginning of this article, lead to a more economical use of sales representatives. Few companies would claim that their sales staff call only on potential customers. In certain cases that have been investigated, over one-third of all calls were unproductive in the sense that they were to companies who were unlikely ever to buy the salesman's products.

This may be exceptional but there is undoubtedly scope to reduce the number of calls made on unlikely buyers; and companies can fall into that category for a good many reasons.

The above are only a few of the more obvious uses to which market knowledge can be put. By and large, the company with the most complete and up-to-date knowledge of the market will score at the expense of competitors.

ATOMIC REVIEW

On the Agenda

Steel for Berkeley—Details of Berkeley reactors and associated plant—Berkeley Contractors—Larger stations—Risks and insurance—C.E.A. expands its nuclear power branch—Excess heavy water—U.S. reactors: EBWR, HRE, PWR and others—Brazilian uranium—Marine propulsion—Conferences and publications—Miscalculation.

Constructional Steel Contract

A contract covering all constructional steelwork for the nuclear power station being built at Berkeley, on the Severn Estuary, has been awarded to the Constructional Steel Division of the Palmers Hebburn Works of Vickers-Armstrongs (Shipbuilders), Limited. Work on the Berkeley site, for which the A.E.I.—John Thompson Nuclear Energy Company, Limited, are the main contractors, began on January 7. The consulting engineers are W. S. Atkins and Partners.

Details of Berkeley Station

Recently, the A.E.I.—John Thompson Nuclear Energy Company revealed some further details of the design adopted for the Berkeley station. (Previous references have appeared in ENGINEERING on December 21, page 793, and December 28, page 828, 1956, and January 25, page 121, 1957.) A sectional view of one of the station's two reactors and its associated plant appears in Fig. 1, and we published a sketch of the site layout on page 122 last week.

Reactors.—Each reactor comprises fuel elements, graphite moderator and supporting steelwork, pressure vessel, shielding steelwork and shield cooling, charge and discharge machines and fuel-handling equipment, burst fuel element detection equipment, control and instrumentation, including control rods and their operating mechanisms, gas storage facilities, main gas circulating ducts, main and auxiliary gas circulators and control, steam raising units and all associated civil engineering work.

Fuel Elements.—The design of the fuel element aims at ensuring that the irradiation period of the fuel will not be limited by the inability of the element to withstand the thermal and nuclear effects to which it is subjected. The fuel elements will be short in length and therefore robust. They will be individually supported in the channels to eliminate such creep effects as would result if the elements were stacked one on another. The length of the elements will be such that creep occurring due to their own weight will be negligible.

Graphite Moderator.—The graphite moderator design is generally based on that developed by the United Kingdom Atomic Energy Authority for the Calder Hall Power Station. The structure will comprise a large number of vertical columns of graphite bricks and tiles, each column being 30 ft. high and separately supported through a ball-bearing assembly on to cross-braced girders. These transmit the weight of the structure to A-frames supporting the reactor pressure vessel. The complete assembly forms a 32 sided regular polygon prism with a vertical axis. Provision is made in the design for Wigner growth and expansion movement generally, and equipment is included for initiation and control of periodic Wigner energy release operations. The geometry and stability of the structure will be preserved throughout the life of the reactor by side restraints in the form of flexible bracelets. The top of the structure will be surfaced by a number of cast-iron cap plates, which will protect the channel entrances and will act as channel guides for the fuel-charging and discharging equipment. The burst fuel element detection pipes will be also located by means of these plates. Special measures will be taken, both during manufacture and during final erection, to ensure that the necessary high standards of cleanliness are maintained within the pressure vessel.

Pressure Vessel.—The pressure vessel containing the reactor core is a vertical cylinder supported on specially designed rocking feet to take up thermal movement. The techniques already established at Calder Hall for the fabrication of this vertical cylinder have been adapted for the new station.

Shielding Structure.—The design of the shielding around the reactor main pressure vessel, gas ducting, blowers and pipework penetrating the biological shield will be adequate in material, geometry and construction to attenuate the radiation to a safe level.

The main biological shield will be of reinforced concrete 8 ft. 6 in. thick. The top shield will be, in fact, approximately 11 ft. thick, but due to control-rod equipment voidages, the effective thickness will be 8 ft. The inner faces of the shield will be air cooled by an induced-draught fan system and protected from neutron bombardment by a steel thermal shield. The cooling air will be filtered before being discharged from the fans into atmosphere by two steel chimneys which extend to a height of 240 ft. above ground level. The fuel-element discharge chute will also be ventilated by this system. These chimneys and associated filters will deal with all gas and active or potentially active ventilating air in a manner compatible with the *Recommendations of the International Commission on Radiological Protection*, as revised on December 1, 1954.

Fuel-Charging and Discharging Equipment.—The fuel-charge and discharge equipment is designed to be capable of loading and unloading fuel with the reactor on load. This entails the inclusion of heavy shielding on the machines to protect the operator from the potential radiation hazard. The design of the machines is such that no parts are left permanently in the reactor and no electrical equipment is introduced into the pressure vessel. The guides and moving parts which are introduced into the pressure vessel are designed to be simple and robust. Irradiated fuel will be removed in shielded coffins from the reactor area and stored under water in special cooling ponds for the necessary decay period of 100 days, after which the fuel can be shipped to the chemical processing plant. Replacement of faulty fuel elements is possible with the reactor at full load.

Burst Fuel Element Detection Equipment.—The burst fuel element detection equipment will be similar in principle to that used at Calder Hall but with detailed improvements. It is designed to detect and locate the failure of a fuel element can sufficiently early to allow removal of the defective element before any significant increase in activity in the coolant circuit can occur. The principle of operation is to make use of the fact that two of the most abundant fission products, krypton and xenon, are gaseous and that these decay to form solid subsidiary products which are themselves radioactive. Samples of the coolant gas will be drawn through tubes from each of the fuel-element channels in the reactor, and passed, after cooling and mixing in groups of four channels, through a multi-selector valve to a filter which removes solid particles, including any radioactive foreign matter. Then they will be passed to an electrostatic precipitation chamber and finally returned to the main coolant circuit by a compressor. In the precipitation chamber the solid subsidiary products, from the decay of the gaseous fission products, will be collected and passed into a counting chamber containing a scintillation counter which measures the beta activity of the deposit. The electrical output of the counter will be measured and recorded, and will initiate the operation of a visual or audible alarm in the event of excessive channel activity.

Control.—The station will be operated from one central control room from which each reactor, its associated blowers and its turbo-alternators will be be adjusted to maintain load at the desired level. With this system great economy in staffing is possible and rapid corrective action can be taken in the event of a fault. Starting of particular plant items will be carried out locally upon telephone instructions from the control-room engineer. Once normal running has been established, control will pass to the central control room. Operating control positions will be provided in the central control room, in the gas-circulator houses in each reactor building, and on the turbine floor in the turbine hall.

The main features of the reactor supervisory instrumentation provided in the central control

room are as follows: (*a*) continuous indication and recording of neutron flux; (*b*) continuous indication of: (i) selected fuel element temperatures, (ii) inlet and outlet coolant gas temperatures, and (iii) position of each control rod; (*c*) pre-selected periodic logging print-cut of fuel-channel activity by automatic typewriter initiated by digital computer system with magnetic drum memory storage; (*d*) comprehensive visual audible alarm system giving ample warning of the onset of a non-urgent fault condition; and (*e*) automatic reactor shut-down system initiated by urgent fault conditions. Electric and pneumatic telemetering systems will relay the readings of reactor instruments to the central control room. Gas circulators, steam raising units and turbines will be provided with standard flow, temperature and pressure measuring instruments, with appropriate telemetering where necessary.

The control of the station output will be achieved by regulation of the reactor gas temperature. Individual items of plant and auxiliaries are first started up and control centralised as mentioned above. The reactor control rods will then be slowly withdrawn with the gas circulators running at a low speed. Following this the plant temperatures will be raised at a controlled rate. When steam production has reached an adequate level, the turbines will be started up by the turbine drivers. At the same time, the steam-raising-unit steam pressures and control-rod positions will be suitably adjusted by the central control room operator to maintain rates

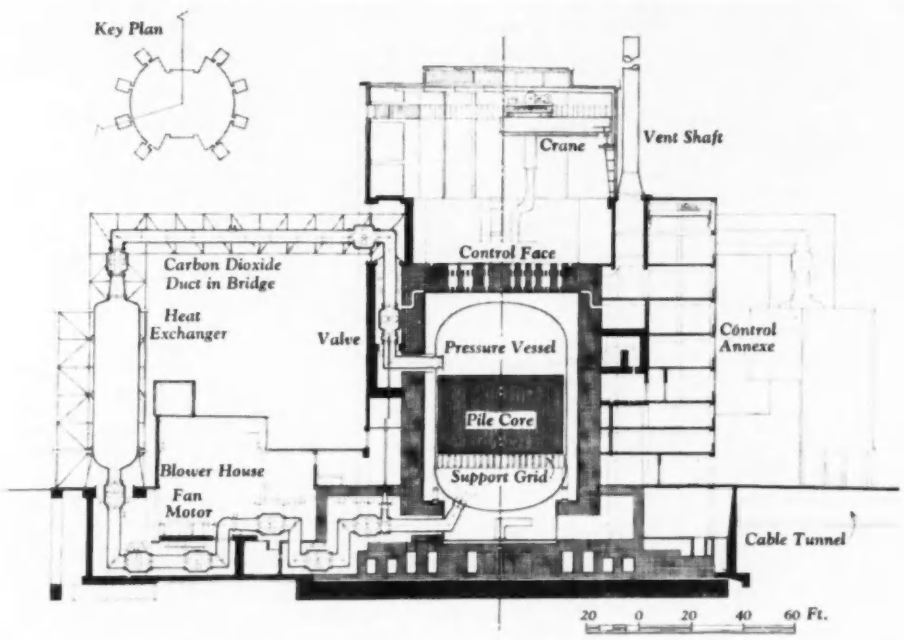


Fig. 1 General arrangement of one of the two reactors for the Berkeley nuclear power station being built by the A.E.I.—John Thompson Nuclear Energy Company at a site on the Severn Estuary.

of rise of reactor temperatures at the desired level. Once the gas temperatures are normal, the gas circulator speeds will be increased as the turbines are loaded up. The turbines will be frequency controlled, and the load changed by speeder gear adjustment. Reactor gas outlet temperatures will be maintained constant at all loads by automatic control of control-rod position. Plant load changing is thus effected by blower speed and turbine speeder gear control only. Automatic control of the latter from high-pressure steam pressure would permit single-switch load control of the whole plant. To shut down, the control rods are run into the reactor in the normal way. Owing to the cooling of the core and the decay of fission products, an output of heat will continue for a very limited period. In an emergency the main gas circulators will be driven by D.C. auxiliary motors during the initial shut-down period, but after a short while the plant will be cooled adequately by the gas flow induced by natural convection.

Contractors at Berkeley

Some additional details concerning the contractors for the Berkeley station have recently been released. The four turbo-alternator sets will be made by the Metropolitan-Vickers Electrical Company, Limited, and Siemens Brothers power and control cable will be used throughout the station; Siemens will also be responsible for the internal automatic telephone system. Sunvic Controls will provide instrumentation. On page 829 of our issue of December 28, 1956, we gave details of the contributions to be made by the British Thomson-Houston Company, Limited (gas circulators, auxiliaries, control gear), John Thompson Limited (1,000 ton reactor pressure vessels, thermal shielding, fuel handling machines, coolant circuits, and the 16 heat exchangers), Balfour Beatty and Company, Limited (civil work on turbine house), and John Laing and Son, Limited (civil work on reactors and heat exchangers). Other companies associated in the group are listed on page 793 (December 21, 1956).

Giant Power Stations

The initial stage in the development of nuclear power seems towards larger outputs from single stations. Thus Lord Citrine, the chairman of the Central Electricity Authority, has said that "There is little doubt that in a further two or three years it will be possible to design nuclear stations with an output of 500 MW." This is about the capacity of the station at Barking. Sir John Cockcroft has gone further, and forecast that beyond 1965 there would be a chain of giant atomic power stations stretching across Western Europe and feeding the bulk of the Continent's electricity needs into a super high-voltage grid. By that time power in industrialised countries would probably be generated in huge blocks of 1,000 to 2,000 MW. He also foresaw that by 1975 Britain's nuclear power stations would be providing power equivalent to 60 or 70 million tons of coal a year.

Insurance

Various sections of the insurance market are making detailed investigations into liabilities pertaining to the development of atomic energy and radiation technology. Underwriters at Lloyd's are also considering the insurance problems arising from atomic energy risks, and a special policy endorsement has been drafted to provide for risks associated with radiation hazards in public liability and certain other types of insurance. The extent of cover will, according to the *Journal of Commerce*, be of particular interest to those industries in which operations involve the use of radioactive isotopes, though the draft refers generally to claims "arising from nuclear fission, nuclear fusion or radioactive contamination." The endorsement does not, however, apply to claims arising from "the operation of any nuclear reactor wherever situated." It appears from the conditions that the underwriters have taken into consideration the cumulative nature of radiation injury, though it is clear that radiation dosage prior to the period of endorsement cannot be assessed.

The European Insurance Committee (60 Mythenquai, Zurich, Switzerland) is concerned with questions of insurance that transcend national frontiers. One of these, which is of growing importance in developing atomic energy, is that of providing the undertakings concerned with insurance cover against the direct and indirect liabilities that may devolve upon them in cases of accidental injury and damage, health hazards, water pollution and atmospheric pollution where plants are set up close to or upstream of the frontiers. A working party was formed which first met in Paris in January, 1956, and has since been resolved into a Permanent Commission on the Atomic Risk and which decided to establish a study centre, now existing at the above address and known by the initials of its French title CERA (Centre d'Etudes du Risque Atomique). This Centre is not in direct contact with insurance companies or even with bodies representing the different branches, but deals exclusively with various national or international associations.

C.E.A. Nuclear Expansion

The Central Electricity Authority is said to be expanding its nuclear power branch to cope with the development of commercial nuclear power stations. A small staff of nuclear engineers is to be enrolled and trained at the Harwell Reactor School. They will eventually be responsible for investigating the behaviour of the reactors in the C.E.A.'s projected plants.

NEWS FROM THE UNITED STATES

Heavy Water

There is reason to suppose that changes in the forecasted demand for heavy water have taken place. The United States Atomic Energy Commission is reported to be closing down one of its two large heavy-water production plants, and it is thought that sufficient has been stockpiled to meet all immediate needs. This decision may have been made for any of several reasons: cheaper methods of separation may have been developed—manufacture as a by-product in, say, fertiliser production, as is proposed in India, is presumably a more economical approach, or the call for heavy water as a reactor moderator may have been over-estimated. A heavy-water moderator gives high neutron economy (as distinct from natural water) and so permits the use of natural-uranium fuel. (In Britain a graphite moderator combined with gas cooling serves a similar purpose.) The heavy water is not expended and consequently demand is simply a function of the number and size of heavy-water-moderated reactors to be built. The plant to be closed down is that at Dana, Indiana, and though its construction was only begun in 1950, it is the older of the two installations, the other being on the Savannah River, South Carolina.

Experimental Boiling Water Reactor

As announced recently in ENGINEERING (January 18), the Experimental Boiling Water Reactor (EBWR) at Argonne National Laboratory, reached criticality on December 1 and produced experimental quantities of electricity on December 23, thus becoming the first of the five experimental power reactors in the A.E.C.'s five-year

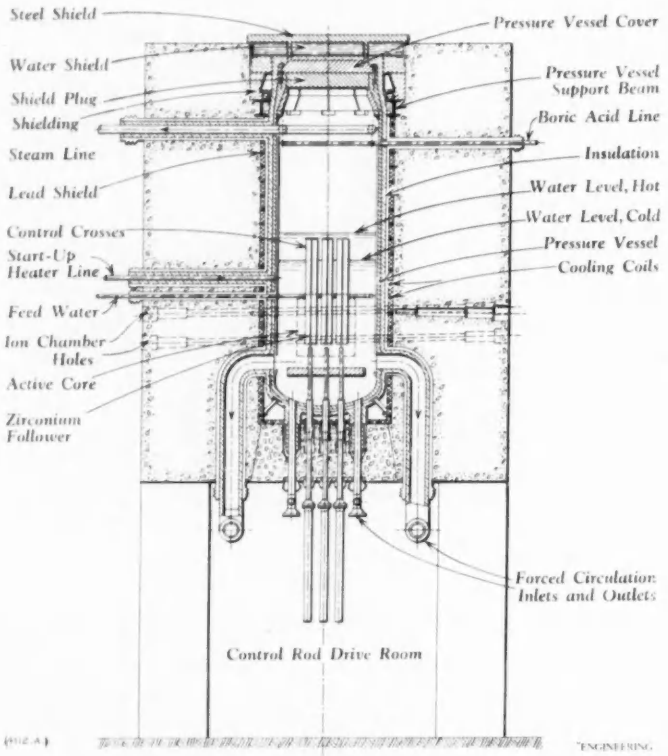


Fig. 2 The United States experimental boiling water reactor (EBWR) recently produced experimental quantities of electricity, and was thus the first of the U.S.A.E.C.'s experimental power reactors to start operation.

plan to start operation. SRE (Sodium Reactor Experiment) and HRE-2 (Homogeneous Reactor Experiment No. 2) are not expected to be far behind but both have suffered start-up delays—SRE because of zirconium fabrication and other difficulties and HRE-2 because of microscopic cracking in the leak detector system (see next section). The PWR at Shippingport (Fig. 4) is expected to start operation in the summer, while the fifth reactor experiment, EBR-2 (Experimental Breeder Reactor No. 2), is not scheduled to reach full power until 1959.

The design of the EBWR, which is shown diagrammatically in Fig. 2, is partly based on operating experience and data obtained from the BORAX experiments at Argonne (described in Geneva papers 851 and 481); BORAX-3, it will be remembered, was the first U.S. reactor to supply experimentally the power and light for an entire city, in July, 1955. EBWR will produce 20 MW of heat and 5 MW of electricity, this being the minimum capacity considered necessary to permit sound extrapolation to large-size power stations.

The core of the EBWR, approximately 4 ft. in diameter and 4 ft. long, contains 77 natural and 36 enriched uranium interchangeable fuel elements (4,536 kg. natural and 66 kg. fully enriched uranium) giving an over-all enrichment of 1·44 per cent. Each element consists of six uranium-niobium-zirconium alloy plates (0·271 and 0·208 in. by 3·625 in. by 48 in. active length), clad in Zircaloy-2 and welded to Zircaloy side plates to form a box assembly with 0·379 in. and 0·442 in. coolant channels. The core is contained in a steel pressure vessel, 7 ft. in diameter, 25 ft. high, and 2·25 in. thick, clad with stainless steel. Stainless steel, 1 in. thick, inside the pressure vessel and 3 in. lead plus 7·5 ft. concrete outside provide the necessary thermal and biological shielding.

Steam, at 253 deg. C. (488 deg. F.) and 600 lb. per sq. in. (gauge) is generated in the reactor core itself, thus eliminating the need for an external heat exchanger and enabling the steam temperature and pressure in the turbo-generator to be as high as in the reactor vessel. Another important feature of boiling water reactors is that an increase in demand leads to a lower reactor pressure, an increase in the steam volume and a reduction in the reactivity and power level. They thus have good nuclear stability although the usual control methods (5 hafnium and 4 boron steel cruciform rods in EBWR) are, of course, necessary. The major problems of boiling water reactors are carry-over of radioactivity to the turbine and development of reliable fuel elements.

Two full-scale boiling water reactor power plants are planned: a 180 MW (electricity) plant by Commonwealth Edison Company, at Dresden (ENGINEERING, November 23, 1956, page 670), and a 22 MW (electricity) plant by the Rural Co-operative Power Association at Elk River, both for completion in 1960. In addition, a 5 MW turbo-generator is being installed to utilise the surplus heat from the reactor being built by General Electric Company at Livermore as a pilot plant for the large Commonwealth Edison reactor.

Homogeneous Reactor Delay

Microscopic cracking in the leak detector system of the Homogeneous Reactor Experiment No. 2 at Oak Ridge National Laboratory will delay start-up of the reactor temporarily. In addition to the damage to the leak-detector system, which was observed in the course of non-nuclear test operation of the reactor system, there is some evidence of similar damage to flanges in the high-pressure system to which the leak-detector system is connected. The reactor itself is not affected. The cracking is ascribed to stress corrosion and is believed to be the result of chloride ion contamination of stainless-steel tubing in the leak-detector system. It has been decided to replace the leak-detector tubing and some of the flanges forming part of the high-pressure system.

Further non-nuclear test operation of the reactor are being continued into February. After these tests it may be found necessary to replace all the flanges in the high-pressure system. The flanges in the low-pressure system may also be replaced as a precautionary measure. It is not considered advisable to retain in the system any flange which has shown evidence of stress corrosion cracking. If it becomes necessary to replace all of the flanges, start-up of the reactor could be delayed until the autumn of 1957. A two-region reactor vessel as may be used ir HRE-2 is shown in Fig. 3.

(HRE-2 is one of several reactor experiments being conducted under the Commission's civilian power reactor development programme. In the homogeneous reactor system the fuel is dissolved in a liquid moderator which is circulated as a coolant. The Oak Ridge National Laboratory, operated by Union Carbide Nuclear Company, has primary responsibility for the development work on this concept. The Laboratory has successfully operated a homogeneous reactor experiment designated the HRE-1, which was similar to the HRE-2. The HRE-1 was dismantled in 1954 after two years of operation to make way for the more advanced HRE-2. Some data for HRE-2 were published at the Geneva Conference and are as follows: initial operation to be with heavy-water blanket system; fuel solution to be dilute solution of uranyl surphate (about 90 per cent. uranium 235) in heavy water, 9·6 gm. uranium 235 per kg. heavy water; power level 10 MW; later operation to use thorium oxide suspension in heavy water in blanket system, and uranium 233 to be substituted for uranium 235. Design bases: inlet fuel solution temperature 256 deg. C., outlet 300 deg. C.; fuel circulation rate 400 gal. per min.; control by variable solution concentration, negative temperature coefficient (-2×10^{-3} per deg. C.); core inside diameter 32 in., at 2,000 lb. per sq. in. abs.; 14 in. thick blanket, blanket inside diameter 60 in., 2,000 lb. per sq. in. abs., wall thickness 4·4 in.; core material Zircaloy-2, system of stainless steel (347)).

Two Reactors in One

Two reactor systems are combined in an experimental reactor at the Argonne National Laboratory. Known as ZPR-5, it is said to unite the advantages of a fast reactor (which has no moderator) with those of a thermal reactor. A fast reactor with enriched uranium fuel is surrounded by what is virtually a second reactor, which employs fuel elements in the form of rods and is water moderated (presumably heavy water with natural or only slightly enriched uranium as fuel). The outer reactor is built in sections so that no single section is alone large enough to sustain a chain reaction, and the operation of this reactor is used to control the operation of the internal fast reactor. Breeding takes place in the outer reactor's natural uranium fuel rods, as in the blanket of a normal fast breeder reactor. Although no details have yet been given concerning the criticality relationship of the two systems, the critical assembly of each is presumably dependent on that of the other. It is understood that the main advantages over ordinary fast breeder reactors are likely to be in ease of control and neutron economy.

Shippingport Reactor

Transporting the pressure vessel for the Shippingport nuclear power station has involved many problems, which have been successfully tackled by the Dravo Corporation. Dravo, of Neville Island, Pittsburgh 25, Pa., are responsible for installing the entire nuclear section of the plant, which includes a pressurised-water reactor constructed by the Westinghouse Electric Corporation.

Details of the plant, which is being built for the A.E.C. and the Duquesne Light Company,

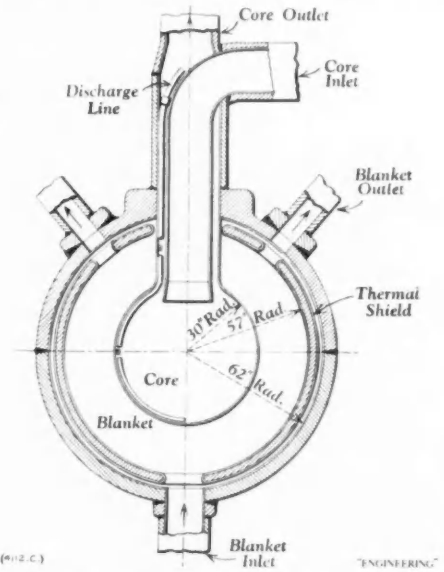


Fig. 3 Two-region reactor, as used in the aqueous homogeneous system, with concentric inner and outer cores. Starting up of the homogeneous reactor, HRE-2, has been delayed.

were given in ENGINEERING on December 14 (1956), page 761. The operation of installing the vessel is illustrated in Fig. 4. The suspension system was designed to lift not only the support frame and the 153 ton vessel but also the insulation and the inner and outer neutron shield tank walls, which are attached to the vessel, making a total of 245 tons. The entire unit rests on a welded steel base, set in the concrete floor of the underground reactor containing sphere.

GENERAL NEWS

Uranium in Brazil

A report from Brazil states that a uranium deposit, said to be one of the richest in the world, has been found in Sao Paulo State near the Minas Gerais border.

Ships

The building of a British merchant ship powered by nuclear energy is becoming a vexed question. Last week shipowners and shipbuilders held a meeting under the auspices of the General Council of British Shipping and the British Shipbuilding Research Association to discuss the subject. During the meeting reports were presented by 16 representatives of the shipping industry who had been attached to the Harwell establishment, but no decision on construction of a prototype was reached. The shipping industry appears to be of the opinion that nuclear propulsion must be demonstrably economic before companies can be expected to go ahead without Government subsidy. This is no doubt a reasonable attitude in certain respects, but there is at present some danger that Britain may be left behind in this field. Japan, Norway, the United States and the Soviet Union are all said to be engaged on nuclear powered marine projects, though only the American and Soviet projects are likely to be beyond the planning stage (see ENGINEERING, page 29, January 4, 1956).

Mr. R. Maudling, Paymaster General and spokesman for the Minister of Power, has stated in the House of Commons that the United Kingdom Atomic Energy Authority, the Admiralty and the British Shipbuilding Research Association are making considerable efforts in the development of nuclear power for use in surface vessels and submarines. It is specially interesting to note the Admiralty's part in this work; for by their insistence that vessels purchased under Government contract shall take advantage of the best modern techniques (including nuclear power) the re-tooling necessary for the next stage in marine development may be accomplished. A Naval team of engineers, constructors, electricians and scientists headed by a Naval engineer officer has been working with Atomic Energy Authority staff at Harwell for some years on a submarine project. Their studies (of reactors, shielding, fuels, health and safety, and capital and operating costs in connection with marine propulsion) puts the Admiralty in an ideal position to take the lead together with other authorities and interested parties in judging how best to tackle a merchant ship project.

Though it is no doubt true that Britain will one day have a large nuclear powered tanker as described in our note on ships and submarines last week, it should be emphasised that Sir John Cockcroft in his Paris talk was referring only in a general way to such a vessel. Work is certainly being carried out on reactors capable of propelling ships of the size and speed described, but a decision to go ahead with a particular project has yet to be taken. At the present stage and high costs of development of the marine propulsion machinery, however, the shipbuilding industry could hardly be expected to underwrite such a project, and if we are to proceed it can only be done in the first instance with Government sponsorship. It is to be hoped that an official announcement concerning this problem will shortly be made.

Conferences

1957 *Nuclear Congress.*—First details have been announced of a 1957 Nuclear Congress to be held at the Convention Hall, Philadelphia, Pa., from March 11 to 15. The programme is being co-ordinated by the Engineers Joint Council, 29 West 39th-street, New York 18, N.Y., and will include more than 200 papers. The Congress is being sponsored by 20 engineering and technical organisations including the American Nuclear Society and in addition there will be conferences for business executives and an International Atomic Exposition. More than forty major topics will be considered at the Congress, including nuclear generating stations, reactors for ship propulsion, disposal of radioactive wastes, processing and fabrication of nuclear fuels, legislative and legal problems, atomic energy developments abroad and commercial applications of nuclear techniques in such fields as chemical production and food processing.

Het Atoom.—The United Kingdom Atomic Energy Authority has announced that it will exhibit at Het Atoom, the international atomic energy exhibition which is to be held this year in Holland from July 1 to mid-September. The organisers of the exhibition have been informed that the Authority's main exhibit will include a model, over 18 ft. long, of the Calder Hall nuclear power station. Other exhibits illustrating the Authority's work in the production of isotopes will also be sent to the exhibition. The purpose of the exhibition is to demonstrate to the general public how atomic energy may be applied to peaceful purposes.

Conference on Radioisotopes.—An international scientific conference on the use of radioisotopes in research will be convened by the United Nations, Educational, Scientific and Cultural Organization next September in Paris. Preliminary discussions on the scope and organisation of the conference took place at a meeting in Unesco House on January 14 and 15 of scientists from eight countries (Brazil, the United States, France, Japan, India, the United Kingdom, Czechoslovakia, and the U.S.S.R.). Observers present from the World Health Organization, the Food and Agricultural Organization, and the European Organization for Nuclear Research promised the support of their organisations for the conference. More than 1,000 scientists are expected to attend the conference, the purpose of which will be to provide a broad exchange of information on newest developments in the use of radioisotopes as instruments of research, as tracers or as sources of radiation. The last conference of this nature was held in 1954 at Oxford under the auspices of the Atomic Energy Research Establishment, Harwell. The conference will work in two main sections, one dealing with radioisotopes in the physical sciences and the second with the biological sciences. The first section will cover such fields as geology and geophysics (including meteorology and oceanography) and metallurgical and industrial research. The second will take up the use of radioisotopes in biochemistry (including plant biochemistry and photosynthesis), human and animal physiological research, nutrition research, basic medical research and certain branches of agricultural research, including soil fertility, plant and animal pathology and the use of insecticides.

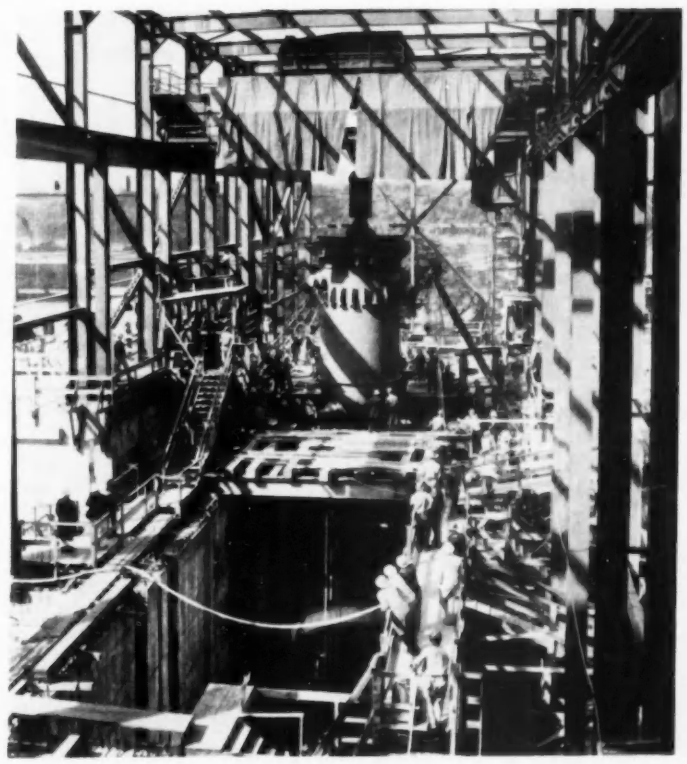


Fig. 4 The installation of the Shippingport reactor vessel required tackle capable of lifting 245 tons. From a flat car the vessel was swung over the fuel-handling canal to a point directly over the underground sphere where the vessel is located.

Publications

Atomic Power Review, of which vol. 1, Nos. 1 and 2 have appeared, is published by W. J. Vogt at 414 Elizabeth House, 18 Pritchard-street, Johannesburg, Union of South Africa. It is described as a monthly review of " atomics and energy, electronic science, research and engineering " and as being the first journal on these subjects to appear in the African Continent. In the initial issue is an atomic energy section consisting of four articles, including two which give an account of atomic research respectively in Britain (by K. E. O. Jay) and in Germany—the latter in four parts by different authors, one of them being by Dr. F. J. Strauss, the German Federal Minister for Atomic Affairs.

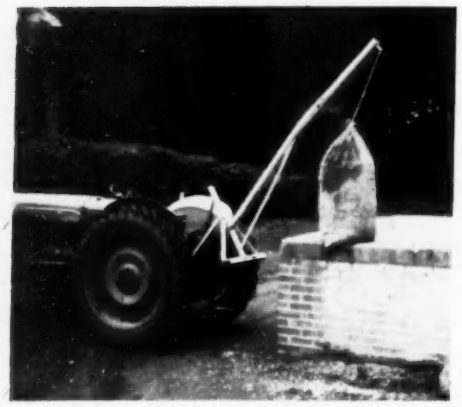
L'atome au Service de la Prospérité et de la Paix is the title of a pamphlet issued by the International Secretariat of the European Movement at 25 rue de Spa, Bruxelles. It begins by quoting statistics as to the relative consumption of mechanical energy in 16 countries. Expressed as the equivalent tons of coal annually consumed per head of population the averages range from 7·62 in the United States through 4·78 in the United Kingdom and 2·49 in France down to 0·01 in Ethiopia. On this basis the importance of developing the use of atomic energy in Europe as elsewhere is stressed. Brief notes follow on the respective parts to be played in bringing this about by endeavours of O.E.E.C. and a European Atomic Commission (Euratom), the latter assuming similar functions to those of the High Authority of the European Movement.

Postscript

When Sir William Haley, the Editor of *The Times*, is confused by a correspondent to a lesser paper with Bill Haley the Rock'n'Roll practitioner, when a senior official from Harwell is mistaken for Liberace, the extent of human fallibility becomes apparent. Error is in fact difficult to avoid, and there must be occasions when misconceptions, misinterpretations or miscalculations appear in Atomic Review. We should be glad to have our attention drawn to such aberrations.

* * *

The Council of the Royal Society of Arts have founded a new award, to be known as the Benjamin Franklin Medal, to be awarded annually " to individuals who have attained early distinction, with promise of future achievement, in the promotion of arts, manufactures and commerce." The first recipient is to be Professor Frederic Calland Williams, O.B.E., D.Sc., M.I.E.E., F.R.S.



In the lowered position, the lifting arm extends beyond the side of the tractor, but as it is raised by the hydraulic system it swings in line so that a towed trailer can be loaded.

TRACTOR-MOUNTED HOIST

A simple hoist for loading trailers has been introduced by the Glenaldie Woodworking and Engineering Company, Limited, Great Haseley, Oxfordshire. It mounts directly on the normal three-point linkage of a tractor, and is operated by the hydraulic control system. It is shown in the illustration. The mounting is such that the tow-bar of the tractor is unaffected and a trailer can remain attached for loading. A feature of the hoist is that as the arm is raised, a link causes it to swing sideways so that a sack can be lifted from the ground beside the trailer on to the trailer or on to a platform as in the illustration. Thus the tractor and trailer can proceed along a row of sacks or cases and load them on to the trailer without pause to unhitch. At present the hoist is available for fitting to Fordson or Ferguson tractors, but models are being developed for other types. The hoist load is limited by the power of the tractor hydraulic system.

★ ★ ★

MULTI-CELL DUST COLLECTOR

The multi-cell cyclone-type mechanical dust collector offers a solution to many of the problems involved in the elimination of stack emissions. The Holmes-Rothemuhle collector is now being manufactured and marketed under licence by the Gas Cleaning Division of W. C. Holmes and Company, Limited, P.O. Box B7, Turnbridge, Huddersfield. High dust-separation efficiency is derived from the relatively small diameter of the individual cyclones which comprise the complete unit. By using a number of such cyclones in parallel the pressure drop across the unit is kept to a minimum.

A unit cell consists of two concentric tubes: an outer flue-gas cylinder with an impeller fixed at the inlet, and an inner clean-gas pipe. A swirl is imparted to the dust-laden gas as it enters the cell causing the dust particles to be centrifuged to the annular collecting space. The dust then gravitates to hoppers below, while the cleaned gas is drawn through the inner tube into the outlet ducting. The complete collector comprises a honeycomb of unit cells welded together to form a compact, rigid structure. The impellers are about 4 in. in diameter and are cast from abrasion-resisting alloy, while the tubes and plates are of mild steel.

A feature of the cell assembly is its economy in space occupied. The collector itself is always inclined, since the back plate forms a chute for conveying the separated dust into the hoppers, but the gas inflow may be axial with the inclined cells (the normal arrangement); vertically downwards; or horizontal. If conditions demand a vertically upward gas inlet, then an alternative arrangement with a reverse-flow cell is used.

NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

LONDON
"Recent Developments in Television," by G. E. Partington. West London Branch. Windsor Castle Hotel, 134 King-street, Hammersmith, W.6. Tues., Feb. 5, 7.30 p.m.
"Radio Valves," with film, by G. H. Gardner. North London Branch. Queen's Head Hotel, 677 Green Lanes, Harringay, N.4. Wed., Feb. 6, 7.45 p.m.

LEEDS
"Ball and Roller Bearings," by J. Warren. Leeds Branch. Great Northern Hotel, Leeds. Mon., Feb. 4, 7.30 p.m.

PRESTON
"Industrial Uses of Alternating-Current Capacitors," by P. R. Coursey. Preston Branch. R.A.F.A. Club, East View, Preston. Wed., Feb. 6, 7.30 p.m.

British Institution of Radio Engineers

MANCHESTER
"Electronics in Medicine," by R. F. Farr. North Western Section. College of Technology, Sackville-street, Manchester. Thurs., Feb. 7, 6.30 p.m.

Building Centre

LONDON
Film Display. Wed., Feb. 6, 12.45 p.m.

Chemical Society

BIRMINGHAM
"Some Current Problems in Phase Transitions," by Professor A. R. Ubbelohde. Birmingham Branch. Chemistry Department, The University, Birmingham. Fri., Feb. 8, 4.30 p.m.

DUNDEE
"Recent Developments in the Chemistry of Metallic Surfaces," by Professor K. W. Sykes. St. Andrews and Dundee Branch. Chemistry Department, Queen's College, Dundee. Tues., Feb. 5, 5 p.m.

DURHAM
"Electron Diffraction by Gases and Its Chemical Application," by Dr. L. E. Sutton. Newcastle and Durham Branch. University Science Laboratories, South-road, Durham. Mon., Feb. 4, 5.15 p.m.

EDINBURGH
"Nucleotide Structure and Function," by Professor J. Baddiley. Edinburgh Branch. Biochemistry Lecture Theatre, Teviot-place, Edinburgh. Tues., Feb. 5, 7.30 p.m.

Combustion Engineering Association

COVENTRY
"Smokeless Operation of Boilers and Furnaces on Solid Fuel," by C. H. G. Hayward, at 10.30 a.m.; and "Smokeless Operation of Boilers and Furnaces on Liquid Fuel," by C. A. Roast, at 2.30 p.m. Leofric Hotel, Coventry. Wed., Feb. 6.

Illuminating Engineering Society

CARDIFF
"Architects' Approach to Lighting," by G. Grenfell Baines. Cardiff Centre. Offices of the South Wales Electricity Board, The Hayes, Cardiff. Thurs., Feb. 7, 7 p.m.

EDINBURGH
"Lighting as an Effective Aid to Architecture," by H. E. Bellchambers, R. V. Mills and H. R. Ruff. Edinburgh Centre. Y.M.C.A., 14 South St. Andrew-street, Edinburgh. Wed., Feb. 6, 6.15 p.m.

GLASGOW
"Lighting as an Effective Aid to Architecture," by H. E. Bellchambers, R. V. Mills and H. R. Ruff. Glasgow Centre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Thurs., Feb. 7, 6.30 p.m.

NEWCASTLE-UPON-TYNE
"Lighting for Photography," by R. W. Unwin. Newcastle-upon-Tyne Centre. Department of Electrical Engineering, King's College, Newcastle-upon-Tyne. Wed., Feb. 6, 6.15 p.m.

Institute of Marine Engineers

BIRMINGHAM
Annual General Meeting. "Free Piston Engines," by P. Watson. West Midlands Section. Birmingham Exchange and Engineering Centre, Stephenson-place, Birmingham. Mon., Feb. 4, 6.45 p.m.*

LIVERPOOL
Annual General Meeting. "Fundamental Principles of Marine Instrumentation," by F. P. Prout. Merseyside and North Western Section. 9 The Temple, 24 Dale-street, Liverpool. Mon., Feb. 4, 6 p.m.

Institute of Metals

LONDON
"Beryllium," by Bengt Kjellgren. London Local Section. Thurs., Feb. 7, 6.30 p.m.*

OXFORD
Discussion on "Surfaces." Oxford Local Section. Cadena Café, Cornmarket-street, Oxford. Tues., Feb. 5, 7 p.m.

Institute of Petroleum

LONDON
"Patents in the Petroleum Industry," by Dr. J. T. Tyson. Wed., Feb. 6, 5.30 p.m.*

Institute of Refrigeration

LONDON
"Antibiotics for the Preservation of Perishable Foods," by Dr. Ella M. Barnes; and "A Discussion of the Possibilities of Using Ionizing Radiations for Preserving Foods," by Dr. R. S. Hannan. Junior Institution of Engineers, Pepys House, 14 Rochester-row, S.W.1. Thurs., Feb. 7, 5.30 p.m.*

Institution of British Agricultural Engineers

BRISTOL
"Economics of Mechanisation of the Small Farm," by S. R. Wragg. Western Centre. Electricity House, Bristol. Mon., Feb. 4, 7.15 p.m.

Institution of Chemical Engineers

LONDON
"Liquid-Liquid Extraction," by H. R. C. Pratt and others. Geological Society, Burlington House, Piccadilly, W.1. Tues., Feb. 5, 5.30 p.m.

Institution of Civil Engineers

LONDON
"Large-Span Prestressed-Concrete Bridges Constructed by the Freyssinet System," by Y. Guyon. Structural and Building Division. Tues., Feb. 5, 5.30 p.m.*
"Employment of Contractor's Plant on Civil-Engineering Construction Works," by R. H. McGibbon and J. H. Brass. Works Construction Division. Tues., Feb. 12, 5.30 p.m.*

HULL
"Design and Reconstruction of West Pier, Royal Dock, Grimsby," by W. M. Sewell and P. H. Jacob. Yorkshire Association. Electricity Showrooms, Ferensway, Hull. Thurs., Feb. 7, 6.15 p.m.

MANCHESTER
Vernon-Harcourt Lecture on "British Waterways, 1931-1956," by C. M. Marsh. North Western Association. Engineers' Club, Albert-square, Manchester. Thurs., Feb. 7, 6.30 p.m.

NOTTINGHAM
"River Control with Particular Reference to the Work of the Trent River Board," by Marshall Nixon. East Midlands Association. Mechanics' Institution, Trinity-square, Nottingham. Tues., Feb. 5, 6.15 p.m.

Institution of Electrical Engineers

LONDON
"The Importance of Research in Hearing and Seeing to the Future of Telecommunication Engineering," by Dr. E. C. Cherry. Radio and Telecommunication Section. Mon., Feb. 4, 5.30 p.m.*
Discussion on "The Place of Liberal Studies in Sandwich and Other Technological Courses," opened by E. H. Horrocks. Education Discussion Circle. Wed., Feb. 6, 6 p.m.*
Third Graham Clark Lecture on "The Place of Engineering in University Education," by Sir Ifor Evans. Joint meeting with the Institution of Civil Engineers and the Institution of Mechanical Engineers. Thurs., Feb. 7, 5.30 p.m.*

BIRMINGHAM
"Technical Development and Training in the U.S.S.R.," by G. S. C. Lucas and D. P. Sayers. South Midland Centre. College of Technology, Gosta Green, Birmingham. Mon., Feb. 4, 6 p.m.*

LEEDS
"Crystal Palace Television Transmitting Station," by F. C. McLean. North Midland Centre. Yorkshire Electricity Division, 1 Whitehall-road, Leeds. Tues., Feb. 5, 6.30 p.m.

LEICESTER
Faraday Lecture on "Nuclear Energy in the Service of Man," by Dr. T. E. Allibone. East Midland Centre. De Montfort Hall, Leicester. Wed., Feb. 6, 7.15 p.m.

MANCHESTER
"Some Aspects of Heat-Pump Operation, with Particular Reference to the Shinfield Installation," by Miriam V. Griffith. North Western Centre. Engineers' Club, Albert-square, Manchester. Tues., Feb. 5, 6.15 p.m.

Institution of Engineering Designers

LONDON
"The Design of Closed-Cycle Air Engines," Part I," by F. J. Watson. Tues., Feb. 5, 6.45 p.m. (*Postponed.*)
"The Design of Closed-Cycle Air Engines," Part II, by F. J. Watson. Thurs., Feb. 7, 6.45 p.m. (*Postponed.*)

Institution of Heating and Ventilating Engineers

LONDON
"Current Practice in School Heating," by L. Oliver. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Thurs., Feb. 7, 6 p.m.

LEICESTER
"School Heating," by J. H. R. Parris. East Midlands Branch. College of Arts and Crafts, Waverley-street, Nottingham. Wed., Feb. 6, 6.45 p.m.

Institution of Locomotive Engineers

DERBY
"Cooling of Diesel Engines," by J. Koffman. Midlands Centre. Midland Hotel, Derby. Wed., Feb. 6, 7 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

* An asterisk is placed where it is understood that tea is available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury-square, London, W.C.1. (LANgham 5927.)
British Institution of Radio Engineers, 9 Bedford-square, London, W.C.1. (MUSeum 1901.)
Building Centre, 26 Store-street, London, W.C.1. (MUSeum 5400.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Combustion Engineering Association, 6 Duke-street, St. James's, London, S.W.1. (WHItehall 5536.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Institute of Marine Engineers, 85 The Minories, London, E.C.3. (ROYal 8493.)
Institute of Metals, 17 Belgrave-square, London, S.W.1. (BELgravia 3291.)
Institute of Petroleum, Manson House, 26 Portland-place, London, W.1. (LANgham 2250.)
Institute of Refrigeration, New Bridge Street House, New Bridge-street, London, E.C.4. (CENtral 4694.)
Institution of British Agricultural Engineers, 6 Buckingham-gate, London, S.W.1. (TATe Gallery 8589.)
Institution of Chemical Engineers, 16 Belgrave-square, London, S.W.1. (BELgravia 3647.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.
Institution of Engineering Designers, 38 Portland-place, London, W.1. (LANgham 8847.)
Institution of Heating and Ventilating Engineers, 49 Cadogan-square, London, S.W.1. (SLOane 3158.)
Institution of Locomotive Engineers, 28 Victoria-street, London, S.W.1. (ABBey 6672.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Production Engineers, 10 Chesterfield-street, London, W.1. (GROsvenor 5254.)
Institution of the Rubber Industry, 4 Kensington Palace-gardens, London, W.8. (BAYswater 9101.)
Institution of Structural Engineers, 11 Upper Belgrave-street, London, S.W.1. (SLOane 7128.)
Junior Institution of Engineers, Pepys House, 14 Rochester-row, London, S.W.1. (VICtoria 0786.)
Manchester Association of Engineers, 18 Booth-street, Manchester 2. (Central 1717.)
North East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle-upon-Tyne 1. (Newcastle 20289.)
Royal Institution, 21 Albemarle-street, London, W.1. (HYDe Park 0669.)
Royal Society of Arts, John Adam-street, Adelphi, London, W.C.2. (TRAfalgar 2366.)
Society of Engineers, 17 Victoria-street, London, S.W.1. (ABBey 7244.)
Society of Instrument Technology, 20 Queen Anne-street, London, W.1. (LANgham 4251.)

Institution of Mechanical Engineers

LONDON
Discussion on "Locking Devices and the Prevention of Loosening of Components." Applied Mechanics Group. Tues., Feb. 5, 6.45 p.m.*
"Economics of Plant Replacement and Renewals," by C. W. Griffiths. Meeting in conjunction with the Industrial Administration and Engineering Production Group. Fri., Feb. 8, 6 p.m.*
ABERDEEN
Thomas Lowe Gray Lecture on "Salvaging of Ships, with Particular Reference to the Empress of Canada," by Captain W. R. Colbeck. Scottish Branch. Robert Gordon's College, Aberdeen. Fri., Feb. 8, 7.30 p.m.
EDINBURGH
Thomas Lowe Gray Lecture. Scottish Branch. North British Hotel, Princes-street, Edinburgh. Wed., Feb. 6, 6.30 p.m.*
GLASGOW
Thomas Lowe Gray Lecture. Scottish Branch. Royal College of Science and Technology, George-street, Glasgow. Thurs., Feb. 7, 7.30 p.m.
NEWCASTLE-UPON-TYNE
Thomas Lowe Gray Lecture. North Eastern Branch. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Mon., Feb. 4, 6 p.m.
SLOUGH
"Fretting Corrosion," by R. B. Waterhouse. Joint meeting of the Eastern and Southern Branches. Good Companions Hotel, Slough. Thurs., Feb. 7, 7.30 p.m.

Institution of Production Engineers

BRIGHTON
"Aspects of Automation," by A. L. Stuchbery. London Section. Old Ship Hotel, Brighton. Tues., Feb. 5, 7 p.m.
HUDDERSFIELD
"Training of Production Managers and Engineers," by G. S. Bosworth. Halifax Section. George Hotel, Huddersfield. Tues., Feb. 5, 7.15 p.m.
IPSWICH
"Production Methods in Large-Scale Engineering Jobbing Work," by Lieut.-Colonel J. F. Rice. Eastern Counties Section. Diocesan Hall, Tower-street, Ipswich. Fri., Feb. 8, 7.30 p.m.

Institution of the Rubber Industry

LONDON
"Publicity for Technical Products," by G. C. Graver. London Section. 26 Portland-place, W.1. Tues., Feb. 5, 6.30 p.m.

Institution of Structural Engineers

MIDDLESBROUGH
"Joints in Steel Rigid Frameworks," by G. Bernard Godfrey. Northern Counties Branch. Cleveland Scientific and Technical Institution, Middlesbrough. Tues., Feb. 5, 6.30 p.m.
NEWCASTLE-UPON-TYNE
"Joints in Steel Rigid Frameworks," by G. Bernard Godfrey. Northern Counties Branch. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Wed., Feb. 6, 6.30 p.m.

Junior Institution of Engineers

LONDON
"Kinematic Design," by R. J. Herbert. Fri., Feb. 8, 7 p.m.*

Manchester Association of Engineers

MANCHESTER
"Post-War Trend of Power-Station Plant Design," by F. J. Hutchinson. Engineers' Club, Manchester. Fri., Feb. 8, 6.45 p.m.

North East Coast Institution of Engineers and Shipbuilders

NEWCASTLE-UPON-TYNE
"Development of Refractory Nozzle Blades for Use in High-Temperature Gas Turbines," by Dr. T. H. Blakeley and R. F. Darling. Mining Institute, Newcastle-upon-Tyne. Fri., Feb. 8, 6.15 p.m.

Royal Institution

LONDON
"The Story of the Turbine, Steam and Gas," by Sir Claude Gibb. Fri., Feb. 8, 9 p.m.

Royal Society of Arts

LONDON
"Mining Education and Training," by Professor I. C. F. Statham. Wed., Feb. 6, 2.30 p.m.

Society of Engineers

LONDON
Presidential Address by E. C. Le Jeune. Geological Society, Burlington House, Piccadilly, W.1. Mon., Feb. 4, 5.30 p.m.*

Society of Instrument Technology

BIRMINGHAM
"Electricity Systems Protection," by B. Copper. Midland Section. Regent House, St. Phillips-place, Birmingham 3. Fri., Feb. 8, 7 p.m.

FUEL CONSUMPTION IN AIRCRAFT

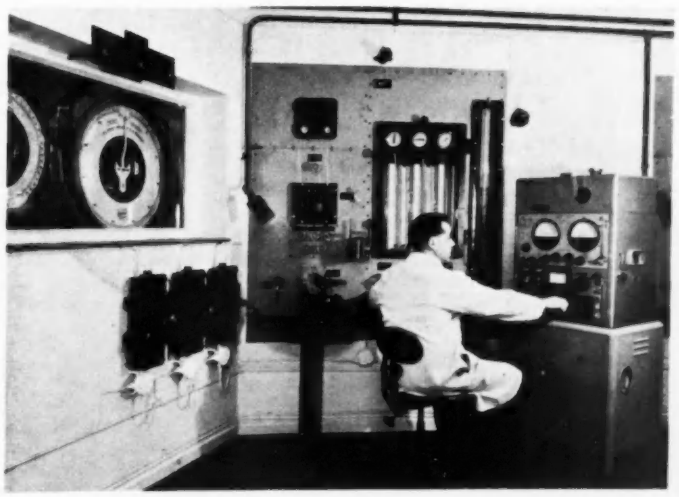
APPARATUS FOR CALIBRATING MASS-FLOW METERS

The advent of the turbine engine has made the measurement and control of fuel flow in aircraft of paramount importance if the maximum operating economy is to be achieved. The control of the rate at which fuel is being consumed as well as knowledge of the amount of fuel remaining are important requirements. Two secondary facts have emerged: that it is the mass of the fuel rather than its volume which must be measured, and that conventional methods of measuring tank contents are inadequate.

A range of flow-meter systems has therefore been introduced by Elliott Brothers (London), Limited, Airport Works, Rochester, Kent, for measuring the fuel flow between the pump and the engine; for those that are being produced for the Victor, Vulcan, and Javelin aircraft, a test-house has been constructed for calibration and test. This test-house was opened recently by the Minister of Supply, the Rt. Hon. Aubrey Jones. A small brick building, the test-house, is surrounded by a turfed area, the object of which is to keep out dust and to prevent fuel from running along the ground in the event of spillage or fire. The building is sub-divided into a number of rooms. An outer room houses pumps, filters, the Rotameters for calibrating the flow transmitters and the associated equipment such as the valves, pressure controllers and pipework. This room is sealed from the observation room by a dividing wall in which are mounted the test rigs, one of which is shown in the illustration. Other rooms in the building contain the electrical supply equipment, the compressed air and refrigeration machinery and equipment for a Kidde carbon-dioxide fire extinguishing plant.

Fuel is drawn from two storage tanks, each of about 750 gallons capacity, which can be heated by a hot-water system or cooled by J. and E. Hall Freon compressors, so that the fuel can be maintained at an exact temperature. For normal testing work this is 20 deg. C. $\pm \frac{1}{4}$ deg. The fuel is circulated by pumps at approximately 30 lb. per sq. in., first through a Phillips' magnetic filter, which cleans it down to a particle size of five microns, and then to the flow-meter transmitter under test. From there it flows through a Rotameter, and thence back to the storage tank through a set of throttling valves. A Fisher pneumatically operated controller maintains the pressure constant at about 30 lb. per sq. in. by by-passing excess fuel back to the storage tank. A Hymatic compressor provides the operating air.

To cover the range of flows required, which is from 50 to 40,000 lb. per hour, a long-range Rotameter is used; of a recently introduced type, it consists of three tubes arranged in series, each being capable, therefore, of passing the full flow.



A long-range Rotameter provides the standard for calibrating fuel-flow measuring transmitters, with capacities from 50 to 40,000 lb. per hour.

As the flow rates increase, so the floats in turn rise in the tubes till they pass beyond their scale into an expanded chamber, where they remain for all higher flow rates. In this way, the complicated switching system for three tubes of different capacities is avoided. (The Rotameter system depends, of course, on a float rising in a tapered tube, the tube diameter increasing towards the top so that as the float rises a greater fuel-passage area is opened.)

For calibrating the Rotameter instrument, there are two weigh tanks, to which the fuel can be diverted; a small tank going up to 55 lb. and a large one up to 1,100 lb. The scale dials for these can be seen on the left of the illustration. Adjustable indicators mounted beside the Rotameter tubes are then set for the different flows, and sufficient accuracy can be maintained over long periods for testing to be carried out on the transmitter units. The tappings on the inlet and outlet pipes to the transmitter under test provide an indication of pressure drop in the instrument by means of a mercury manometer. Tappings are also provided at various points throughout the system for bleeding-off air from within the pipes. Three valves control the rate of flow of the fuel, one under each of the three tubes of the Rotameter. They are coarse, medium and fine controls, giving the necessary accuracy of adjustment. Each test stand is equipped with a vibrator to which is attached the transmitter under test, so that operational conditions can be simulated. Surrounding the vibrator stand is a drip tray connected to the storage tank, and a forced ventilation system ensures the rapid removal of any dangerous fume concentrations. Mounted immediately to the left and above the transmitter under test is the jet for the carbon dioxide fire-extinguishing spray. This operates on a differential temperature basis.

The observer views his indicating instruments through double panels of armour-plate glass, the window in front of the Rotameter being hinged to allow the indicators to be set. To the right of the observer is a movable cabinet containing electronic measuring equipment on which is recorded the readings from the transmitter unit. The ventilation system incorporated in this equipment ensures that there is always a slight air pressure within the cabinet to keep out inflammable fumes. The equipment can either be swung flat against the wall or pulled out to a convenient angle when one operator is alone. Safety precautions include trips in all the electrical circuits and interlocks to ensure that the apparatus is operated in the correct sequence. For example, ventilation fans must be energised before the fuel pumps can be switched on. The carbon dioxide fire-extinguishing system applies to the whole of the building. Operation is either automatic or manual.

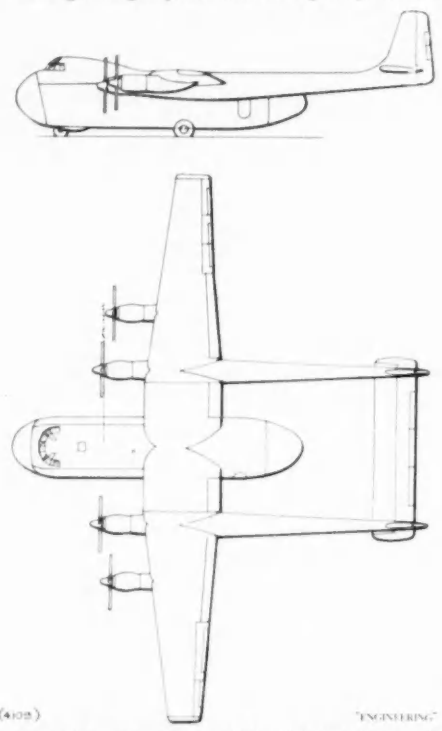
The complete flow indicating system as used in an aircraft consists of the transmitter unit (for which the test house has been built); an amplifier for receiving the signals from it; an indicator showing the flow rate to any one engine; and a second indicator showing the total flow rate and the amount of fuel consumed. From the amount of fuel consumed, of course, there can be deduced the amount left, and therefore the range still available for the aircraft. The basic element of the transmitter is a mass flow measuring chamber, in which a rectangular vane is rotated by the force of the fuel against the restraint of a spring. The vane rotates in a spirally-cut chamber the shape of which limits the passage of the fuel, so that the angle of rotation is directly proportional to the rate of mass flow. A frictionless magnetic coupling transmits the movement of the vane through gearing to the two Autosyns included in the transmitter, one of which feeds the direct flow indicator, and the other, which has a linear voltage characteristic, provides the signal for indicating the total flow rate and the amount of fuel consumed. A separate transmitter is required for each engine fuel line. Although normal testing is carried out at 20 deg. C., the heating and cooling system for the fuel tanks can produce any temperature between -20 deg. C. and $+50$ for type-testing purposes.

FLYING FREIGHT OR TOURISTS

PROJECTED MULTI-PURPOSE AIRCRAFT

Particulars have recently been issued by Sir W. G. Armstrong Whitworth Aircraft, Limited, Coventry, of their " Freightliner " transport aircraft that they now have on the drawing board. Intended as a versatile freight-carrier or, alternatively, for tourist " coach " travel (80 passengers) or military transport (70 fully-armed troops), it has been designed for rapid turn-round, economy in operation and easy maintenance. As shown in the accompanying illustration, the airframe is of the twin-boom type so that it is possible to have both front and rear loading doors extending the full width of the fuselage. The cabin floor is at truck-loading height. In the standard version, the fuselage is pressurised, but an alternative unpressurised version can be made available for use as a car ferry, capable of accommodating up to six cars and 30 passengers. The aircraft is to be powered by four Rolls-Royce Dart propeller turbines; possibly, a twin Tyne-powered version will also be developed.

A high-wing layout with a high-aspect ratio



Full-width loading doors will be fitted at both ends of the fuselage of the Armstrong Whitworth Freightliner; the cargo capacity is 3,680 cub. ft., and the short-range payload is 28,000 lb.

wing has been chosen, the two-spar wing structure, of light alloy, being " based on a well-proven Avro design with a long background of operational use." Spring tabs will be fitted to the control surfaces, which will be manually operated. Double-slotted flaps, hydraulically actuated, will be fitted, and the retractable undercarriage will also be hydraulically operated. Cabin pressure will be provided by three engine-driven blowers giving a maximum differential pressure of 5½ lb. per sq. in.; the wing de-icing system will be fed with hot air ducted from the power-plant heat exchangers.

The dimensions of the projected aircraft are as follows: span, 115 ft.; length, 86 ft. 9 in.; height, 27 ft.; gross wing area, 1,419 sq. ft.; aspect ratio, 9·32; fuel capacity, 3,300 Imperial gallons; gross freight volume, 3,680 cub. ft.; and hold floor area, 426 sq. ft.

Initially, the Freightliner will be certificated at an all-up weight of 76,000 lb., for which a take-off field length of 3,500 ft. will be required. The manufacturers expect to develop the aircraft to an all-up weight of 82,000 lb., which will call for an airfield length of 4,200 ft. The estimated mean cruising speed, at an altitude of 25,000 ft., is 296 m.p.h.

With fuel reserves for 230 statute miles cruising, plus ¾ hour " stand off " while awaiting permission to land, the estimated payload and range are give in the table below:

Range, statute miles	Payload, lb.
500	28,000
1,000	26,500
1,500	22,000
2,000	17,500

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RECORDING TELEVISION PROGRAMMES

The recording of television programmes on film —telerecording—is an established feature of broadcasting. It allows selected items to be kept for future use. But it poses difficult mechanical problems. If one film frame is used for each complete picture on the television screen, the film must move a complete frame during the interval between pictures. This interval varies between 1·4 and 1·8 millisec. The time required to pull down one frame can be longer without losing much definition. However, for a true reproduction the strict limits should be adhered to. Until now the pull-down times of conventional cameras have been much too long. With such cameras it was necessary to blank off every other television frame and move the film during this period. Since every complete television picture is composed of two television frames, there was a marked loss in quality.

The telerecording equipment type BD.679 made by Marconi's Wireless Telegraph Company, Limited, Chelmsford, Essex, has a new fast pull-down mechanism. This normally operates in 2 millisec. but the makers claim that it may be adjusted to give a pull-down within the blanking period. A very light gate pressure is used and positive registration is achieved against a sapphire-tipped claw. The pull-down mechanism is enclosed in an oil bath. The recording monitor, which generates an intense high-quality picture for filming, may be swung through 90 deg. to ease removal of the cathode-ray tube. Any magnetically focussed tube of a diameter between 5 and 10 in. can be used in this position.

The equipment has been installed in the German studios of Bayerischer Rundfunk, and the B.B.C. has similar equipment in use.

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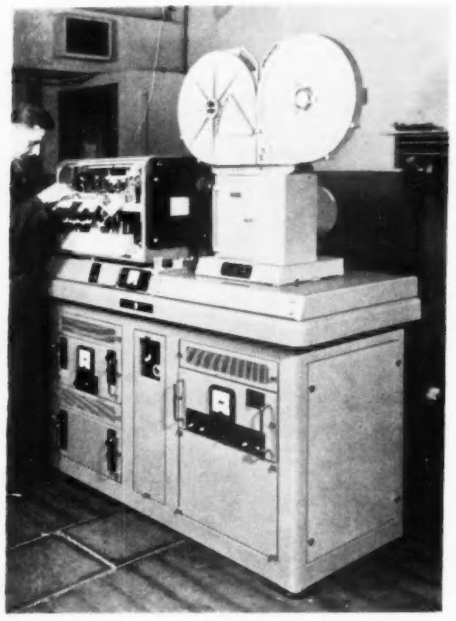
LOUDSPEAKING TELEPHONES

Voice-Operated Talk-Listen Switch

Loudspeaker intercommunication systems have certain advantages over the conventional telephone handset. The user has, in particular, complete freedom of movement to take notes, consult files, or move about while speaking. There is, however, one feature of loudspeaker systems that is generally found a hindrance in normal operation: unless there is a talk/listen switch to prevent acoustic feedback from the loudspeaker to the microphone, a " howl " will override any messages that are being handled. If this switch is manually operated the system has little advantage over the normal handset except in certain circumstances. On the other hand, if a voice-operated switch is incorporated a channel of considerable flexibility is obtained:



Equipment for recording television programmes on 16 mm. film. The monitor screen is situated in the black panel facing the camera unit.

this solution has been adopted by the General Electric Company, Limited, Magnet House, Kingsway, London, W.C.2, in a recently introduced loudspeaking telephone. The equipment consists of a desk-mounting cabinet, housing the loudspeaker and microphone, and an amplifier unit which is designed for wall mounting, remote from the desk, if necessary. When a speech signal is connected to the amplifier, in either direction, the wanted through connection is made and the unwanted path is attenuated. If both parties speak at once, the louder signal seizes the path and the other is suppressed. Although this preference would appear anti-social—or even a wilful surrender to the loudmouthed fellow at the other end—it is essential, otherwise background noises would achieve priority over speech. For incoming calls of a private nature a conventional handset is provided. A subsidiary of G.E.C., the Reliance Telephone Company, markets the equipment in Great Britain.

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The sum of £20,000 has just been given by the Shell Petroleum Company to assist in the establishment of a laboratory in Sedimentology in the Department of Geology in the University of Reading. The major aim of the present grant, apart from the encouragement of post-graduate research, is the creation of a national laboratory as a focus for the resources and work at present dispersed over several institutions. The choice of Reading University was prompted by the successful inclusion, for more than 20 years, of sedimentology as part of the degree course in geology;

The G.E.C. loudspeaker telephone is so arranged that when both parties speak at once, the quieter signal is suppressed.

In Parliament

NUCLEAR POWERED SHIPS

Last week was one of particular interest in parliamentary affairs. In the House of Commons, tributes were paid to Sir Anthony Eden and there was a kindly welcome for the new Prime Minister, Mr. Harold Macmillan. A number of matters affecting privilege were raised and, happily a rare event in these days, there was a summons to the Bar of the House to answer a complaint on that ground. On the industrial side, the Customs Duties (Dumping and Subsidies) Bill was read a second time, the Transport (Railway Finances) Bill passed its third reading, and there were debates on the provision of adequate financial arrangements for the building of large oil tankers and on the desirability of introducing certain alterations in some Trade Returns.

Both Houses re-assembled, after the Christmas recess, on January 22 and, among the earliest questions to the Prime Minister was one by Mr. Donald Kaberry (Conservative), who wished to know which Minister would be available in the Commons for dealing with matters relating to atomic energy and to other research problems coming within the responsibility of the Lord President of the Council, the Marquess of Salisbury. He was told by Mr. Macmillan that such matters should be addressed to the Paymaster-General, Mr. Reginald Maudling, who would deal with these questions on Wednesdays.

On the following day, Mr. Maudling made his début in this connection. He informed Mr. John Howard (Conservative), who wanted to know what steps were being taken to speed up the development of nuclear power for use in ships, that the Admiralty, the United Kingdom Atomic Energy Authority, and the British Shipbuilding Research Authority were devoting considerable effort to the development of nuclear power for use in both surface vessels and submarines.

Admiralty scientists and naval officers had been working with staff of the Atomic Authority at Harwell for some years on studies relating to the types of nuclear power plant best suited for various marine applications, the kinds of fuel required, health and safety factors, and capital and operating costs. (Reference to this research is made in our Atomic Review on page 155.)

The British Shipbuilding Research Association had had a team at Harwell for some time engaged in studying the development of nuclear propulsion of merchant vessels, and had sponsored a conference at Harwell last October, which had been attended by both shipowners and shipbuilders. The small research reactor LIDO at Harwell was being used to study shielding problems, which were among the major design considerations in connection with marine propulsion.

Mr. Maudling declined to be drawn into the "rather complicated question" of whether or not Britain was "retaining her customary lead over the United States in developments in this field."

LABOUR IN THE MOTOR INDUSTRY

A number of questions were put to Ministers concerning manpower problems in the motor industry. Mr. Maurice Edelman (Labour) wanted to know what co-ordinating instructions had been given by the Prime Minister to the Departments concerned with the crisis which was developing in the industry. In reply, Mr. Macmillan said that, while he was fully aware of the difficulties which were facing that industry at the present time, he did not consider that any special instructions from him to the Departments concerned were required. Consultations and discussions, of course, were going on between these Departments all the time.

Mr. Iain Macleod, the Minister of Labour and National Service, told the House that about 10,000 employees in the motor industry at Dagenham were then working a three-day week, and that just over 5,000 persons were working a four-day week. Since short-time working began early in December, it was understood that a number of workpeople had voluntarily left the industry to take up jobs elsewhere. He informed Mr. John Parker (Labour) that about 300 workpeople were discharged as redundant at Dagenham in the week ended January 11, and just over 1,400 in the week ended January 18.

As to the steps that were being taken to find other jobs for men displaced in the motor industry at Dagenham, Mr. Macleod told Mr. Parker that everything possible would be done to help those workpeople who registered at the labour exchanges. Notices had been displayed within the motor works at Dagenham for some weeks describing typical vacancies and advising employees needing other jobs to register at an employment exchange near to their homes or to their place of work.

ORGANISATION IN FACTORY INSPECTORATE

A request for information as to the steps being taken to implement the *Report on Staffing and Organisation of the Factory Inspectorate*, and particularly as to the progress that had been made in respect to the Inspectorate's chemical engineering branch, was put forward by Mr. F. T. Willey (Labour). Mr. Iain Macleod assured the House that action was proceeding on all the recommendations made in the White Paper. Some additional staff had already been recruited and other potential employees would be interviewed shortly. The boundaries of the Inspectorate were being adjusted in order to avoid overlapping with the normal Government regional boundaries, and a new division had been established, with headquarters at Newcastle-upon-Tyne. New staff training arrangements had also been introduced.

Most progress had been made, so far, in connection with the General Inspectorate. With respect to the engineering and chemical branch, there were a number of people in the General Inspectorate who possessed the qualifications necessary for employment in that branch. It seemed only fair to offer such persons the opportunity of transferring their services before other steps were taken to fill vacancies, and that course was the one being taken.

Britain's Oil Prospects

Naturally, there has been considerable concern in the House regarding oil supplies to Britain. In this connection, Mr. N. N. Dodds (Labour/Co-operative) asked the Parliamentary Secretary to the new Ministry of Power for a statement in respect to the petrol and oil situation. Mr. Maudling said that the Organisation for European Economic Co-operation had made arrangements for periodic reviews of the oil position in Western Europe and for all available oil supplies to be shared fairly among the member countries.

The first review, which had just been completed, confirmed the broad assumption on which United Kingdom planning had been based, namely, that only about 75 per cent. of normal supplies would become available. There was, therefore, no immediate prospect of relaxing the present restrictions, which, in fact, involved some diminution of the existing stocks of all the major oil products.

Patent Application Delays

Staffing problems at the Patent Office were raised by Mr. Ronald Bell (Conservative). He drew the attention of the President of the Board of Trade to the hardship and discouragement caused to inventors who apply for patents and then have to wait for periods of up to two years before knowing whether their applications could be granted, and he urged that steps should be taken to remedy the position.

In reply, Sir David Eccles, the President of the Board of Trade, said that he was endeavouring to increase the staff at the Patent Office. Among the steps being taken were recruiting at the universities, improving the salary scales of patent examiners, and the appointment of older men. The interval between the filing of a complete specification describing the invention and the granting of the patent was about three years, on the average, at the present time. That period compared with one of one year and two months in 1938. The refusal of an application might occur at any point of time during the examination of the application. The situation was partly due to the shortage of engineers and scientists, about which, Sir David said, he had learned a lot in his previous office, as Minister of Education.

Non-Ferrous Ores in Britain

Sir David told Mr. Ronald Russell (Conservative) that the extent of deposits of tin, tungsten, lead, zinc and other non-ferrous metallic ores in Britain was not known precisely. There were, at present, two tin mines and about a dozen lead and zinc workings in operation in this country. They produced about 1,000 tons of tin, 6,000 tons of lead, and 3,000 tons of zinc a year.

More Space for British Factories

Considerable new factory space has been completed in Britain during the last few years. Sir David informed Mr. G. Nabarro (Conservative) that the figures of such space for each of the years 1951 to 1955, in millions of square feet, were 34, 29, 31, 39 and 41, respectively. The total for 1956 would probably exceed 41 million square feet, but the figure was not yet available.

Industrial Derating Prospects

The new Minister of Housing and Local Government was asked by Mr. A. W. J. Lewis (Labour) to make a full statement on local government finance, rating and valuation, with particular reference to industrial derating. Mr. Henry Brooke replied that he would require a little time to carry through his own study of these important matters, which, he was sure, the House would allow.

Electronic Computers for Clerical Problems

Mr. F. T. Willey asked the Parliamentary Secretary to the Ministry of Works, as the representative in the House of Commons of the Marquess of Salisbury, the Lord President of the Council, how many members of the scientific staff at the National Physical Laboratory are being employed on the application of electronic computers to clerical and administrative work. He was informed by Mr. Harmar Nicholls that two scientific staff were employed full time on this work, with one other member giving part-time supervision.

Heavy Commercial Vehicles

The President of the Board of Trade, Sir David Eccles, was urged by Mr. John Howard (Conservative) to extend to heavy commercial vehicles the reduction from 50 per cent. to 20 per cent. of hire-purchase deposits at present applicable to motor cars, light vans, and motor cycles. Mr. F. J. Erroll, the Parliamentary Secretary to the Department, in a very brief reply, declined to take any such action.

Productivity Team Visits Overseas

Captain H. B. Kerby (Conservative) inquired about visits paid to the Continent by British industrial teams sponsored by the British Productivity Council in the past two years. He also asked as to what action was being taken to follow up the visits of British teams to the United States under the sponsorship of the former Anglo-American Council on Productivity.

Sir David replied that, during the period mentioned, the British Productivity Council had sponsored one visit by a British team to the Continent. All the British teams which visited the United States had issued reports; the last one being published in September, 1954. The follow-up action taken by the Council included organising a large number of conferences throughout this country on the subject of those reports. Further, the Council was publishing *Reviews of Productivity* in the majority of the industries which had sent teams to the United States. Up to date, 27 of these Reviews had appeared. In its work generally, the Council were making use of the knowledge of American practice and outlook gained by these team visits to the United States.

THE HUMAN ELEMENT

Readable information on careers—Works training on the grand scale—Sociologists' analysis of games—Miners and railwaymen continue wage demands—Problems of paper payments—A building comedy that can bring tragedy.

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Guiding the Graduate

" Degrees are like false teeth. You'd rather not be without them, but you don't flaunt the fact that you've got them to the world." So begins, with commendable sense and a faint flavour of legitimate exaggeration, one of the introductory articles in *Directory of Opportunities for Graduates* 1957. The idea behind this compendium is a good one and is well executed. Granted that the graduate is to be interested in finding the right job in this age of scarce technical expertise (a working assumption that cannot by any means be taken for granted as part of the average graduate's attitude) there is every reason to give as much information as possible about as many concerns as possible in a readable form. This the directory sets out to do with some success.

A short introduction has been written by Viscount Chandos (the project seems to owe a good deal to the Institute of Directors) and a number of people with first-hand experience in recruiting graduates, especially for industry, have contributed. Some of the articles are reprinted from the handbook put out by the Federation of British Industries called *A Career for the Graduate in Industry*, and the whole of the opening editorial section of just over 34 pages will repay reading by those who would recruit graduates and by graduates and undergraduates alike. The information on the companies listed is necessarily brief, but is sufficient to make anyone genuinely and actively interested seek more in the right quarter.

Channeling graduates into the right kinds of jobs to suit their qualifications and aptitudes is not an easy task, but it is a vital one in the national interest. The directory contains much useful information and sets out to catch the eye of the casual graduate reader by an, at times, rather light-hearted treatment. It has much to recommend it to the mannered indifference of many newly-fledged graduates.

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New Training Amenities

Vauxhall Motors have now doubled the size of their Education Centre in order to increase the supply of the trained men they will need when their £36 million expansion scheme is completed. The new premises will enable the company's education and training division to handle 250 trainees at a time. The division as a whole controls the instruction of some 851 young people and employs 39 full-time instructors. Two-thirds of the new building's 30,000 sq. ft. is taken up by a workshop equipped with " a comprehensive range of modern machine tools and other engineering plant." Class-rooms, drawing offices, stores, a conference hall, staff rooms, administration rooms and a gymnasium take up the remaining 10,000 sq. ft.

The range of subjects taught indicates that Vauxhall do not intend to be hamstrung by a shortage of skilled men suitable for promotion to managerial grades. In addition to the formal apprenticeship courses in practical and theoretical engineering, instruction is given in English, civics, industrial history, book-keeping, shorthand, typewriting and office practice. Training facilities exist for those who wish to qualify for membership of professional institutes in accountancy, photography and catering. Management training courses are organised for all from supervisors upwards, and voluntary evening courses are run in a wide variety of subjects.

Since this announcement was made, Vauxhall have restored full-time working and are to take back some of the 1,800 men they laid off during the past four months. The scale of the company's efforts to secure their requirements of skilled labour suggests that they anticipate considerable further growth despite the set-backs of 1956.

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The Sociologist is Watching You

Sport has never been just a matter of playing games entirely for pleasure or of watching other people doing so. The Greeks had definite ideas about the meaning of sport and even the British in modern times have built clouded educational and philosophical ideas around it. To-day, it is considered anything from a state industry to a waste of time—depending on the point of view of the country concerned. UNESCO has recently produced a brochure in its " Educational Studies and Documents " series called *The Place of Sport in Education*.

From this comparative study it is clear that national opinion varies considerably about the educational value of physical exercise of all kinds. In countries like Australia (where sport is a national relaxation and a source of acute partisanship) it is highly favoured, but the commercial build-up organised by the Press is viewed with concern. In Eastern Europe, sport is woven into the local political philosophy. In Spain, the element of public spectacle is viewed with suspicion. No doubt the bull-fighting tradition is influential here. In France, sport is apt to be considered as educationally irrelevant in a country with a great cultural heritage to sustain. For the French, *le sport* is not for the young.

However varied the reactions to sport may be, there is certainly a great deal of thought given to its social implications the world over. There is a good deal of agreement about the need to teach all forms of physical instruction by means of a properly trained corps of teachers whose professional status should be recognised. On the whole, in this atomic age, the idea that anyone wants to do physical jerks or kick a ball around, just because they want to, is a very unsophisticated idea. It is just possible, however, that it is true.

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Rejected Offers

Two offers by employers were rejected last week. The National Union of Railwaymen found the British Transport Commission's offer of about three-and-a-half per cent. increase for nearly all grades too small in relation to the 10 per cent. they had claimed. They will now take their case for a 10 per cent. increase to arbitration. A delegate conference of the National Union of Mineworkers rejected the compromise agreement on " bonus shift " proposed by their leaders, and instructed them to re-open negotiations for the complete abolition of the arrangements. Meanwhile, the miners' president, Mr. Ernest Jones, announced the N.U.M. executive's intention to press for a general increase of 19*s.* 6*d.* a week for all day-wage mineworkers.

The railwaymen's position is complicated by the various unions carrying out their negotiations separately. Besides the N.U.R., the Transport and Salaried Staffs Association are awaiting the B.T.C.'s reply to a claim for a substantial increase and a sliding scale system which would raise salaries in step with the cost-of-living index when it went up, but would not reduce them when it went down. The third union, the Associated Society of Locomotive Engineers and Firemen, have accepted the arbitration award of 3 per cent. but intend to submit a new wage claim if they think it justified—in other words, they will act immediately if the N.U.R. members are awarded a greater increase.

On the whole, a quick settlement is more likely in the case of the railwaymen than the miners. There has been no suggestion that the N.U.R. will not accept the tribunal's findings, which may well be for an increase similar to that rejected last week. Although less is at stake, there is more determination in the miners' stand. The delegates made it clear that there is considerable opposition in the lodges to the system whereby miners get paid for six shifts if they work five, but only for shifts worked if less than five. They want the extra money merged with the ordinary shift payment and will accept no compromise, e.g., no disqualification for men with good records.

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Wages by Cheque

A new version of the Cheques Bill has had deleted from the previous version a proposal to legalise the payment of wages by cheque where there was agreement to do so between the employer and employee. The idea has indeed met with official trade union opposition. It is a pity that this is so. The issue raises no great matters of principle in relations between management and labour, but the decision of the T.U.C. to oppose it is a setback to the extension of modern administrative methods in matters of payment.

So far as wage earners are concerned there is some evidence that they are somewhat confused about what is involved. Workers interviewed in the north of England have appeared to be against the new idea—but for not very impressive reasons. Their attitude has been one of mild resistance to something new, prejudice and ignorance playing about equal parts. Some have said that they have never had dealings with banks and are clearly confused into thinking that payment by cheque at the end of the week will involve them in the unpleasant novelty of running a current account. Into this they have read that it will be difficult to budget from week to week.

Some have said that it will mean that they will have to divulge to their wives how much they earn. Others have adduced the exact opposite from payment by cheque and are greatly attracted to the idea in consequence. The power politics of the household may indeed be the basic factor in the attitude adopted by many men. Whoever cashes the cheque is obviously in a strong position. If the man does it, he can keep his own counsel and fix his own pocket money. Where his consort cashes it she can, if she is strongminded enough, budget the lot and her husband may be home a little sooner on a Friday night.

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Fixing a Ceiling

Demarcation issues between unions are part of the price that has to be paid for technical change. They offer often enough both comedy and tragedy. The tragic side was clearly evident last year in the long-drawn-out demarcation dispute in the shipbuilding yards of Cammell Laird. A fresh example of the comedy (and potential tragedy) comes from Hull.

An emergency dispute tribunal has had to be called hurriedly in Leeds to decide who should hang ceilings in a shop. The Amalgamated Society of Woodworkers are involved with the National Association of Operative Plasterers. After half the shop in question at Hull had been completed, the contract for installing the ceilings changed hands. Up to this point the actual work had been in the hands of the joiners. The change of contractor touched off the trouble. The ceiling covering is to consist of heating panels, and the conflict of interest has arisen over who shall twist the metal fasteners on to the suspended ceiling frames. Plasterers normally hang ceilings but somebody somewhere has pointed out that the metal hangers replace wood. By now no doubt all concerned would give a good deal if this last inspiration had never been uttered.

With the growing interest in heating engineering this sort of development over shop fittings could have serious repercussions. It alerts all interests involved and places an added obstruction, at least potentially, in the path of desirable technical change.